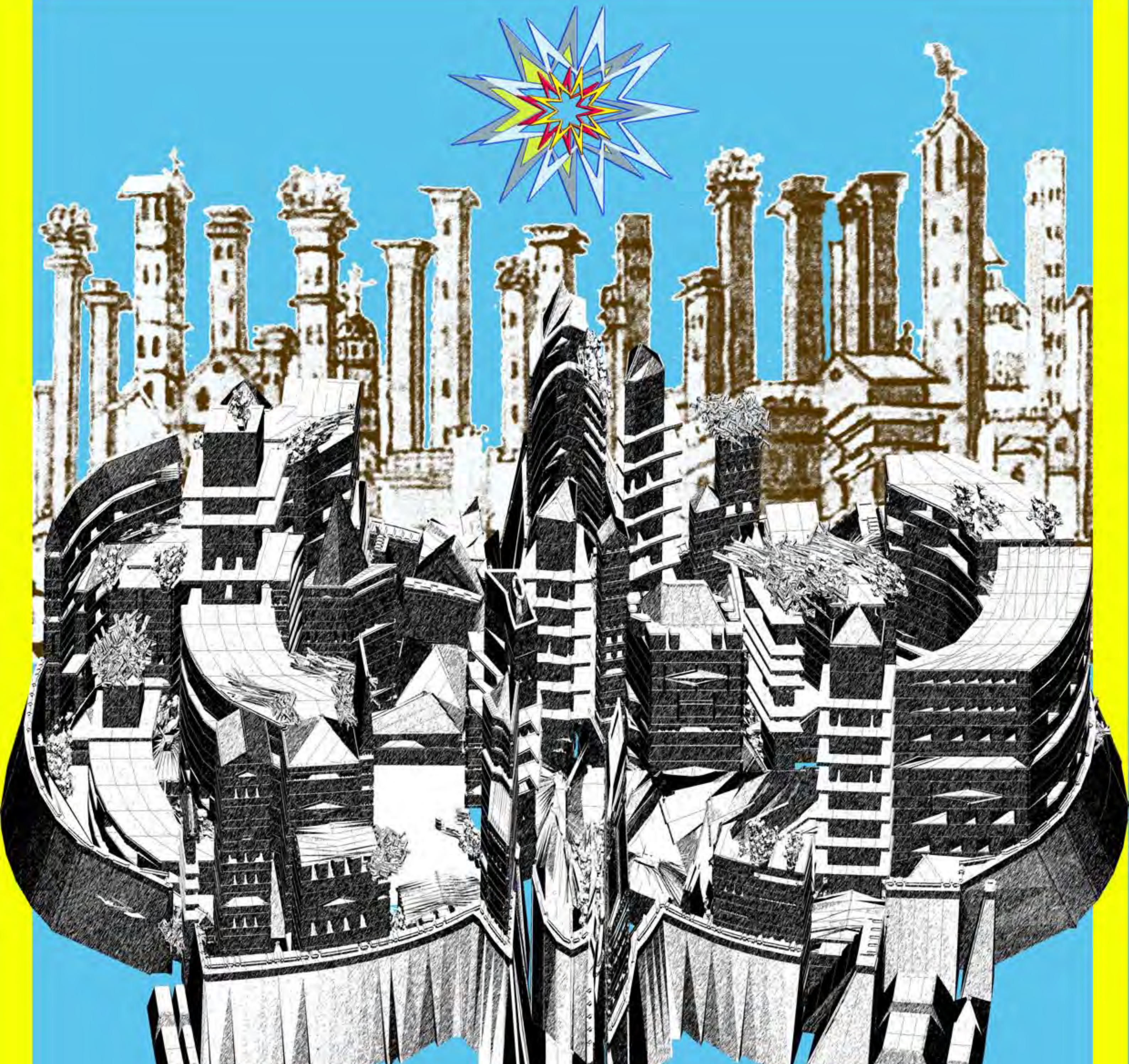

GENERATIVE ART

Proceedings of GA2012
XV Generative Art conference
edited by Celestino Soddu

Domus Argenia
www.generativeart.com

"...*Ars sine scientia nihil est*", Jean Vignot, 1392

In the cover :
"Generative Medieval Cities, interpreting Lucca with generative logics".
A Visionary 3D scenarios generated with Basilica by Celestino Soddu, 2012.

Each proceedings book is personally dedicated to a GA2012 participant as author with an unique cover representing one variation of 50 variations of Generative Scenarios of Lucca

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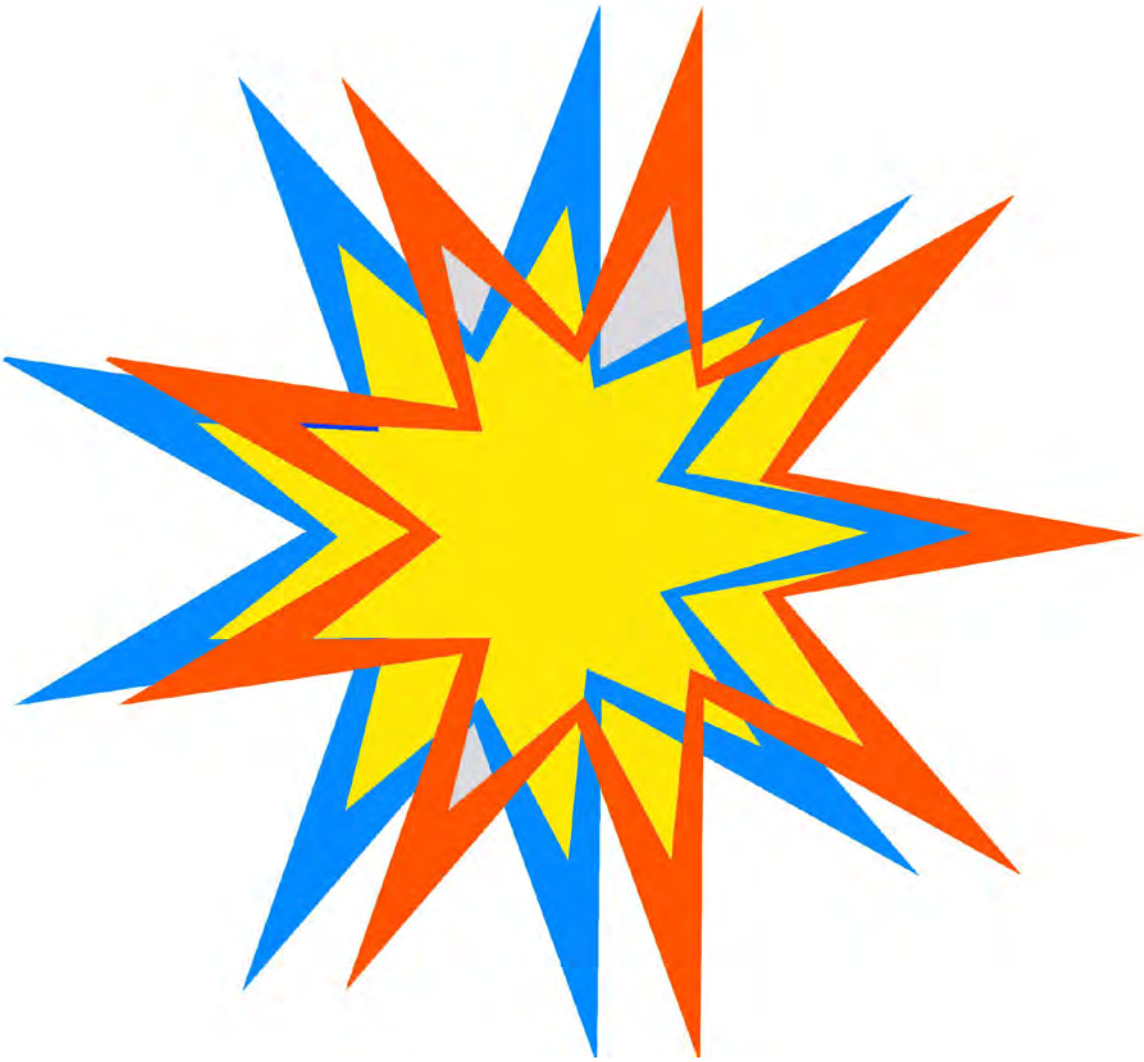

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Generative Design Lab - Politecnico di Milano University, Italy
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Generative Art, the Art of Generating

*Fifteen years. When, fifteen year ago we met together at Politecnico di Milano for the first GA98, **Generative Art** was a not-used term. We chosen it following its multi-disciplinary meaning, instead of other terms focusing the field of peculiar interests like Generative Systems, Design, Music and so on.*

*We have chosen the term Art because **Art** identifies the **Art of Generating**, as well as the **Science of Generating**. Referring to its meaning in Latin where Ars is the synonymous of Science. As in Science, Art identify the strong relationship between a subjective vision, knowledge, feeling, observation, logics and the ability to develop and perform the character and identity of each possible result. Not forgetting that Art, as Science needs to reach results able to answer to inter-subjective needs and requests as the aesthetic character of artworks can do. More, Art is appliable to all field and this term identifies a cross-disciplines approach. Art is Science. As well as Science is Art.*

Today, after fifteen years, Generative Art is a term widely used all over the world. A lot of universities have their Generative Art courses, many artists and musicians identify themselves as generative artists.

On the other side, Generative Art seems to be an abused term, with simplified definitions able to include all approaches and experimentations that are experienced using advanced technologies. Generative Art seems to be homologous of other terms like Software Art, Algorithmic Art and similar terms that focus what tool is used, software, algorithms, and not how the Art of Generation is experienced.

Following many attempts in defining it, Generative Art seems to be the same of Generative Systems, Autonomous Systems, Evolutionary Systems and other similar terms that identify how to perform generative tools and not how to perform the Art of Generation. Making confusion about the difference between tools and aims.

Now, after fifteen years from the first use of this term for identifying a common field of interest and answering to the need of all us, as well as hundreds of participants to Generative Art conferences, we have to take care of this term by going in deep in clarifying the character, the uniqueness, the recognizability and the creative philosophy of Generative Art. Discussing together how, in the multi-disciplinary field of Art and not only of tools, a creative approach could be really generative.

Many contributions of the participants to this XV Generative Art conference will talk about that, and we are happy that we will go ahead in taking care of this particular, young but ever growing common field of interest.

At the end of this XV conferencer a round table to discuss it is planned, and we should like to involve all the participants. More, our aim is to develop an article for our new Journal, GASATHJ, with the report of this round table.

Celestino Soddu, Enrica Colabella, Chairs of GA conference
Lucca, 30 November 2012

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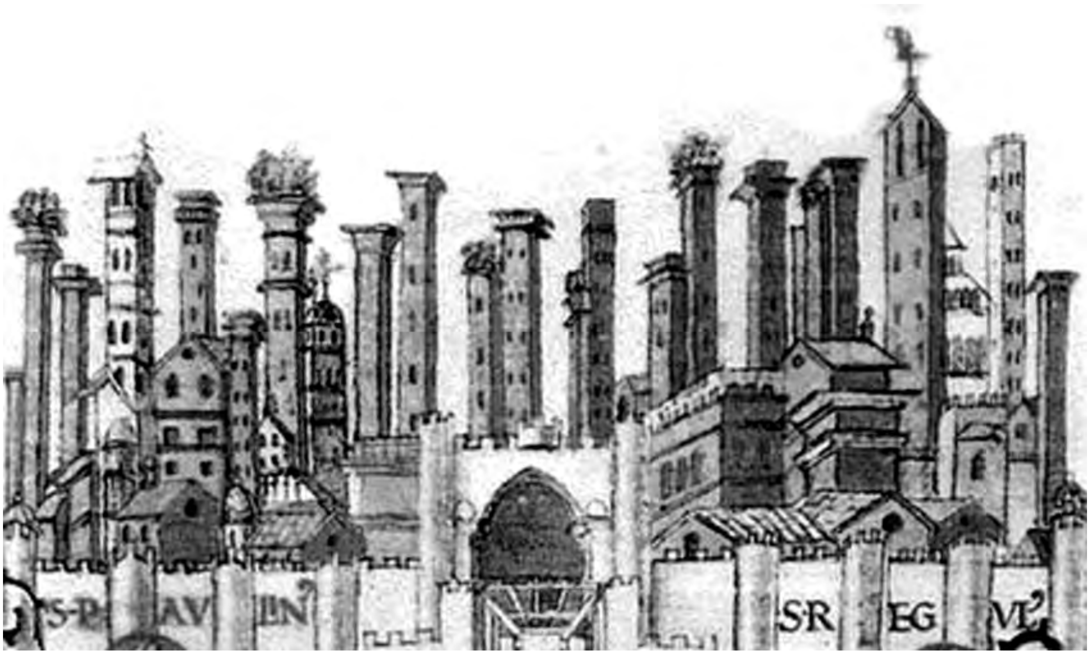


PAPERS

Alan Dunning

DOPPELGANGER: A TECHNOLOGICAL GHOST

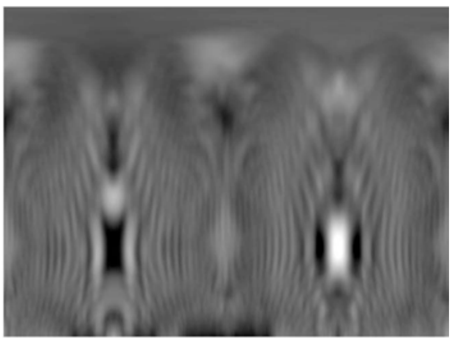
Abstract:

This paper explores some issues arising out of an artwork investigating how images are constructed in media spaces, Using the model of the Doppelganger – a tangible double or look-a-like - new forms, looking or sounding like someone or something, but having no index in the real world, are constructed by a machine in response to incomplete data.

The paper speculates about the development of a technological ghost evolved purely from a machine. Doppelganger uses interleaved image sources to create a copy of an original made up of entirely machine imagined data. The fields of a video source are separated and interpolated. The resulting images are interpolated again, but this time only using the initial interpolated data as the foundation on which to build a new interpolation. This is repeated until new forms begin to emerge - looking like vaguely the original but composed of entirely new material.

Initially, looking like degraded images of dolls or action figures, or twins or Jeckylls and Hydes, or sadder or happier version of themselves the duplicates are built on the digital DNA of the original, but have moved away from a stable state, reinvented by machinic algorithmic dreaming to take on a life of their own. In this work, as in all machinic representation, the tasks of interpretation are left to a machine using a precedent of an existing state to predict future representations within the medium itself.

What the original images and the interpolations have in common are approximates: shape, pose, mass, dimension, though even this disappears if the process is allowed to continue unchecked. What they have lost is an indexical connection to an original. Created from imagined indexical information through reiterated interpolative algorithms, these are not bad copies, nor simply copies of copies, but new forms that emerge out of autonomous and contingent entropic zones.



Screen Capture: Doppelganger, 2012

Topic: Art

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References:
http://people.ucalgary.ca/~einbrain/new/doppelganger/doppelganger.html

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Keywords:
Doppelganger; interpolation; feedback; algorithmic dreaming;

DOPPELGANGER: A TECHNOLOGICAL GHOST

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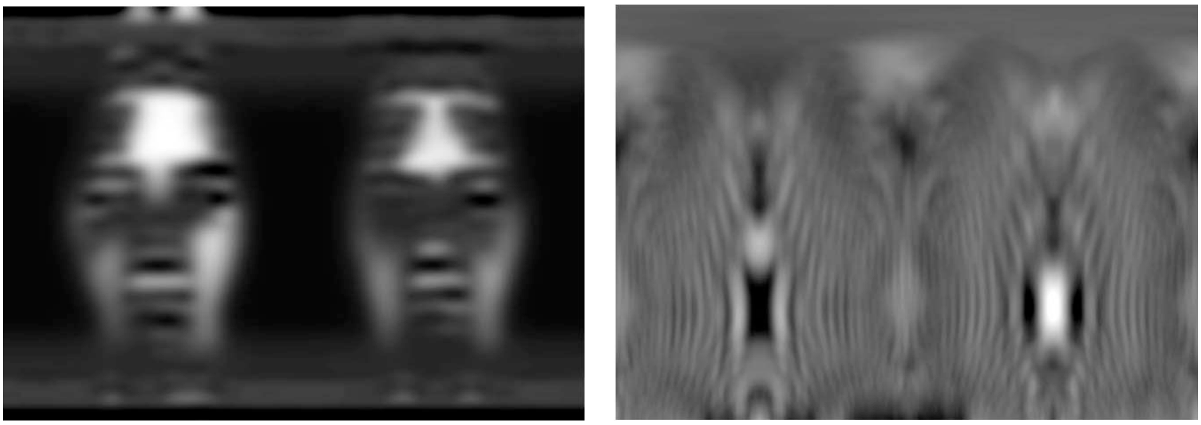
Premise



Screen Capture: Doppelganger, 2012

This paper explores some issues arising out of an artwork investigating how images are constructed in media spaces, Using the model of the Doppelganger – a tangible double or look-a-like - new forms, looking or sounding like someone or something, but having no index in the real world, are constructed by a machine in response to imagined data, input continuously via a feedback loop.

The paper speculates about the development of an unpredicted technological ghost evolved purely from an increasingly autonomous machine. Doppelganger uses interleaved image sources to create a copy of an original made up of entirely machine imagined data. The fields of a video source are separated and interpolated. The resulting images are interpolated again, but this time only using the initial interpolated data as the foundation on which to build a new interpolation. This is repeated until new forms begin to emerge - looking like vaguely the original but composed of entirely new material.

Generations

Doppelganger uses the decisions of a machine's internal workings. It has conceptual connections to the long tradition of chance mechanisms used to develop art forms that can be seen in the widely known work of Duchamp, Cage and many others, but in the end it is less to do with chance than with the unpredictable, deterministic chaos that can be seen in the early video experiments of Steina and Woody Vasulka and their use of analog video feedback. [1]

The unpredictable images generated in Doppelganger are determined by their initial input and an initial set of instructions. No external, no random elements are involved in their generation. They are produced through simple interpolation rules. A simple max/msp patch continually sorts the image into two new images comprised of odd and even fields and interpolates the missing field of each to produce two full images with both fields present. Using linear interpolation the missing pixels are reconstructed by averaging the pixels directly above and below, and uses the average of the previous and future frame lines for deinterlacing. The process establishes a positive feedback loop in which a preceding decision affects a future re-iterated decision. A simple averaging results in unpredictable images that emerge over time, through massive reiteration. Tiny decisions grow to control the system, invisible micro-events amplified to visibility. The machine becomes an autonomous generator of images, of art forms, through processes initiated by, but progressively more distant from, a human impulse. In the end (40,000 iterations and counting) the resulting images are spawned by what must be considered, even as they are still driven by an initial set of instructions, emergent/generative processes almost entirely detached from their beginnings.

The worlds of Western literature, art, myth and religion can furnish us with many examples where the notion of the unitary self has been put into question, where singularity has been superseded by the double, by anonymity and by the hetronymous. Occurrences of these types are related to questions of reality versus appearance, identity, origin, authenticity and social catastrophe. The most recent crisis has been brought about by the technologies of the computer and the proliferation of the digital that has radically transformed ideas of who we are, and more importantly, who we are to become. Digital technology and its *show thyself* [2] transformational space has made commonplace to take on other identities, to invent avatars, to lead fantasy lives, to become a fiction, and to live in other worlds, suggesting that identity and the worlds which we inhabit are fluid atemporal and aphysical constructions:

…digital virtuality has seemed bent upon enlarging the gaps that separate its times and spaces from the coordinates of the material world, coordinates that need bodies to have experience…Yet what is nevertheless forming across all kinds of virtual environments, those where time compacts and space intensively unfolds , is the production of a new kind of embodiment. [3]

The new kind of embodiment requires different models of self, which take into consideration the unfolding of time and space and ones that are attuned to a mode of active perception.

Writing in 1965, Donna Haraway challenged the prevalent notions of machine/organism interaction. … *we are all chimeras, theorized and fabricated hybrids of machine and organism, in short we are cyborgs.* [4] Her vision is as important now as it was then as we move much closer to a Cyborgian world.

Neurologist Antonio Damassio described identity as a moment to moment construction, a transient entity, incessantly reconfigured for each and every object with which the brain interacts. The notion of what constitutes consciousness is vital to such a position:

Our traditional notion of self, however, is linked to the idea of identity and corresponds to a non-transcient collection of unique facts and ways which characterize a person. My term for that entity is the autobiographical self. [5]

We can see that the autobiographical self is a useful economic and practical social tool, but at the same time it doesn't really account for the complex perceptual processes that go on in the brain and body in the construction of the world which we inhabit. In a sense the autobiographical self impedes, hides and desensitizes our own creative actions and desires.

Parallel with the expanding and developing technologies of communication and representation in scientific research and artistic production, the notion of identity has undergone a transformation. In the past, the notion of self has been directly linked to the physical limits of the body constituting a more or less objective and stable make up. Presently this locative conception of the body has been extended to include all places where electricity can power and spawn communication devices and systems. It is common now to speak of the body as distributed and the mind as extended.

Felix Guattari writes:

…the machine's environment forms part of machinic agencements. The liminal element of the entry into the machinic zone undergoes a kind of smoothing process, of the uniformisation of a material, like steel which is treated, deterritorialized and made uniform in order to be moulded into machinic shapes. The essence of the machine is linked to procedures which deterritorialize its elements, functions and relations of alterity. Hence it will be necessary to speak of the ontogeny of the technical machine as that which makes it open itself to the exterior. [6]

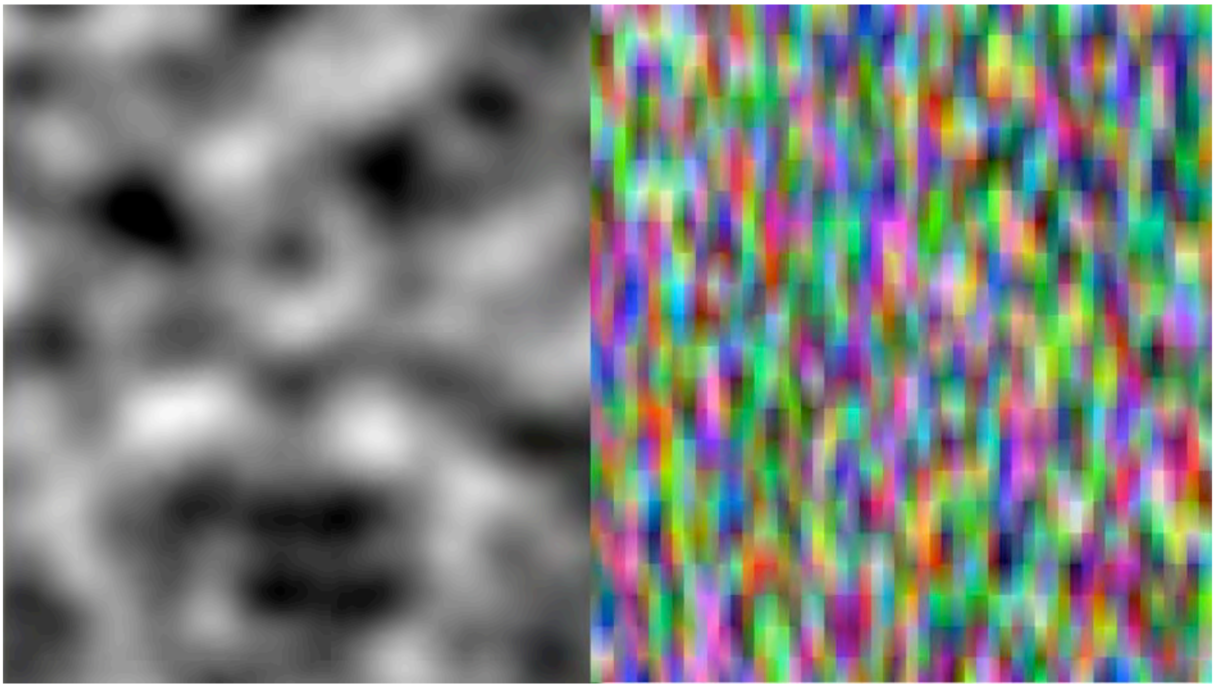
Thomas Metzinger's approach which bridges both sciences and humanities appears to be quite radical in comparison to the accepted and conventional notions of identity. He begins with the premise that selves do not and have never existed in the world. The idea that we have a self is an illusion. What does exist however are *…phenomenal selves as they appear in conscious experience. …the phenomenal self is not a thing but an ongoing process: it is the content of a transparent self-model.* [7]

Using Damassio's idea of identity as a moment-to-moment construction, Metzinger's notions of the phenomenal self, and Guattari's grasp that the technical object cannot be limited to its materiality, the work of the Einstein's Brain Project suggest that the world is increasingly populated by entities that are manifestations of the energy flows of a new electro-biotechnical space, spawned from the perturbations of bodies in motion. Set free from the constraints of time and space, from the territorialization of both mind and matter, these are considered as atemporal and aspatial beings existing in a nether world at the intersection of material and being.

Electro-technical reproduction has changed the nature of images that occupy new media spaces. Moving from pareidolic imagining towards a new symbiosis between man and machine in which the pareiodolic act is modified and amplified by the interpolative acts of a machine, images are detached from matter, increasingly non-indexical, and, significantly, auto-indexical. The processes involved recall the difficulties contained within the Bootstrap Paradox, in which objects can exist even though they have never been created. This time travel paradox describes a situation in which information or an object is sent back in time, it is recovered in the present and becomes the very object/information that was initially brought back in time in the first place.

This echoes what Brian Winston has called technologies of seeing:

Digitalization destroys the photographic image as evidence of anything except the process of digitalization. The physicality of the plastic material represented in any photographic image can no longer be guaranteed. For documentary to survive the widespread diffusion of such technology depends on removing its claim on the real. There is no alternative. [8]



Ghosts in the Machine 2009

In Doppelganger, Medium and ColourBlind what was once, as shown in earlier works like Sound of Silence (2008) and Ghosts in the Machine (2009) the act of pattern and gestalt, might now be act of pure hallucination, Detached from reality, built not from material presence but from the internal processes of a machine/human interpretative system, it suggests that not only has there has been a seminal transformation of the image, but a profound physiological change in how we see.

Some years ago the project imagined a series of bodies in an attempt to identify presences that inhabited the energy fields that we engineered. Briefly these were: the Conscious Body (a body linked to consciousness, the awareness of both the external and internal functioning that can be felt, sensed, and expressed through non-verbal feelings), the Absent Body (a virtual body that must be consciously and repeatedly reanimated to maintain its purchase in a virtual world), the Active Body (a point in space from which emanates events and forces that ripple through and alter the immediate and distant environment), the Mnemonic Body (a repository for memory and events), and the Amplified Body (the body projected into the world, as the processes of the body are made visible and audible).

What at the time seemed all too fanciful and insubstantial now seems too physical, too lodged in earlier conceptions of matter, and need be replaced by conceptual entities even less rooted in the physical world, and even more situated within the electro-biotechnical medium that is deterritorialized matter.

This medium contains only flows and charges. Positive and negative moments that cause undifferentiated matter to move to new locations, and potentially form pattern. Always in flux, the medium pulses into new arrangements faster or slower than can be perceived. The electro-biotechnical medium cannot contain either fixed or indexical moments. Given this what kinds of entities can possibly exist within the medium?

In deciding which entities count as selves, one could look at how entities develop characteristic traits, dispositions and personalities. In a classical physical world this is relatively clear. I am not (normally) you, unless the context allows it; this object is not interchangeable, or even merely confused with that object. In the electro-biotechnical medium characteristics are less certain and less fixed. Microsecond changes in fields, flows and charges account for a medium that is in constant movement, to the extent that all appears over time to be undifferentiated. What might be determined at the millisecond level is no longer visible at the speeds that humans perceive and process data. How then to proceed if entities are imperceptible, lying below our perceptual threshold as micro-durational states and processes? The act of perception itself provides a path.

The Project's most recent environments are exaggerated to the limits of emptiness. In these, fields of undifferentiated colour, of repetitive processes so minutely incremental, or so slow, or conversely so rapid that moment-to-moment activity is rarely seen, it is only after many hours that any signs of activity emerge.

In this electro-biotechnical medium matter is entirely dispersed and deterritorialized, change in any entropic balance is detected as marks, or clusters of activity, or anything that is noticeable in an otherwise unbroken field. In the works *Doppelganger* (2011 -), *Medium (2011 -)* and *ColourBlind* (2010), it is the slow revision of data, or perhaps even the excitation of data, the evidence of self, that reveals pattern and form.

Doppelganger uses interleaved image sources to create a copy of an original made up of entirely machine imagined data. The fields of a video source are separated and interpolated. The resulting images are interpolated again, but this time only using the initial interpolated data as the foundation on which to build a new interpolation. This is repeated until new forms begin to emerge - looking like vaguely the original but composed of entirely new material.

Initially, looking like degraded images of dolls or action figures, or twins or Jeckylls and Hydes, or merely sadder or happier version of themselves the duplicates are built on the digital DNA of the original, but have moved away from a stable state, reinvented by machinic algorithmic dreaming to take on a life of their own. In this work, as in all machinic representation, the tasks of interpretation are left to a machine using a precedent of an existing state to predict a future, but in doing so creates only temporary entropic zones, suggesting that there are unseen, unstable, allopoeitic representations within the medium itself.

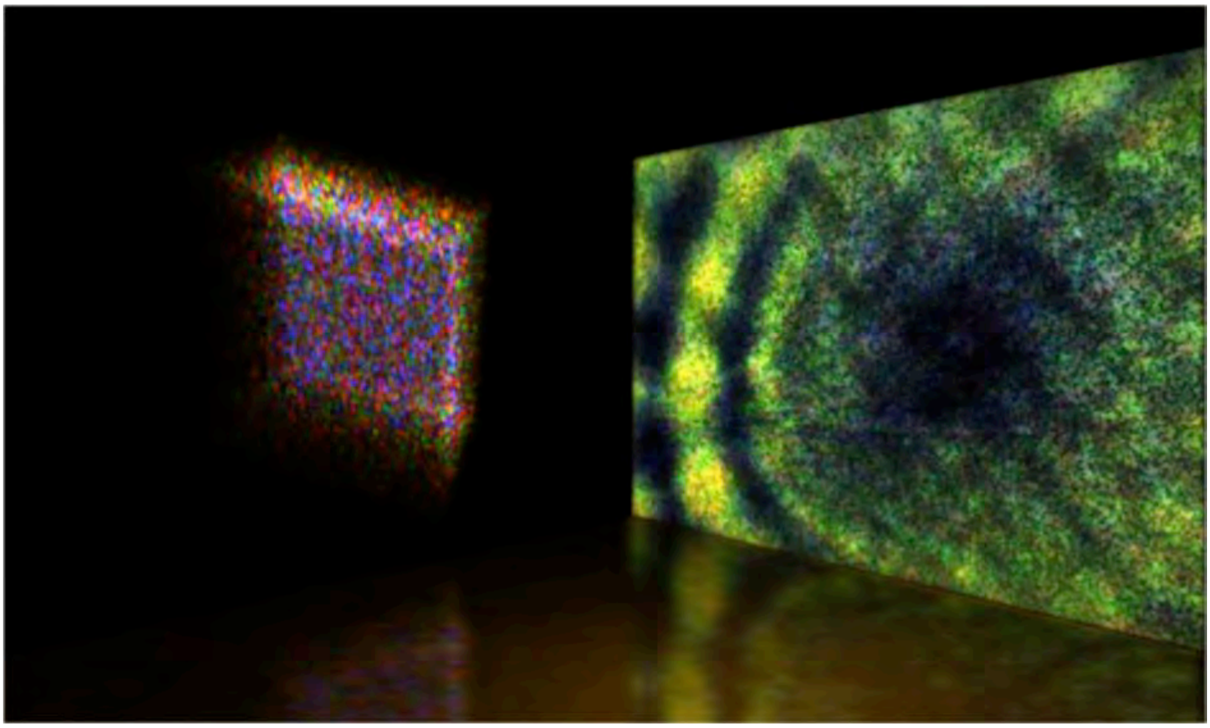
Doppelganger, 2012

What the original images and the interpolations have in common are approximates: shape, pose, mass, dimension - though even this disappears if the process is allowed to continue unchecked. What they have lost is an indexical connection to an original. However, the very thing lost through an absent index is regained in a new presence that is the result of the detachment from its original source. New forms emerge precisely because they become auto–indexical. Created from imagined indexical information through reiterated interpolative algorithms, these are not bad copies, nor simply copies of copies, but new forms that emerge out of autonomous and contingent entropic zones.

In Doppleganger, images appear initially familiar, yet their appearance becomes increasingly novel due to the instability, (this thing now, that thing later), and continual transformation, that is the result of their flight from the indexical. It is a world constructed on an aesthetic of disappearance.

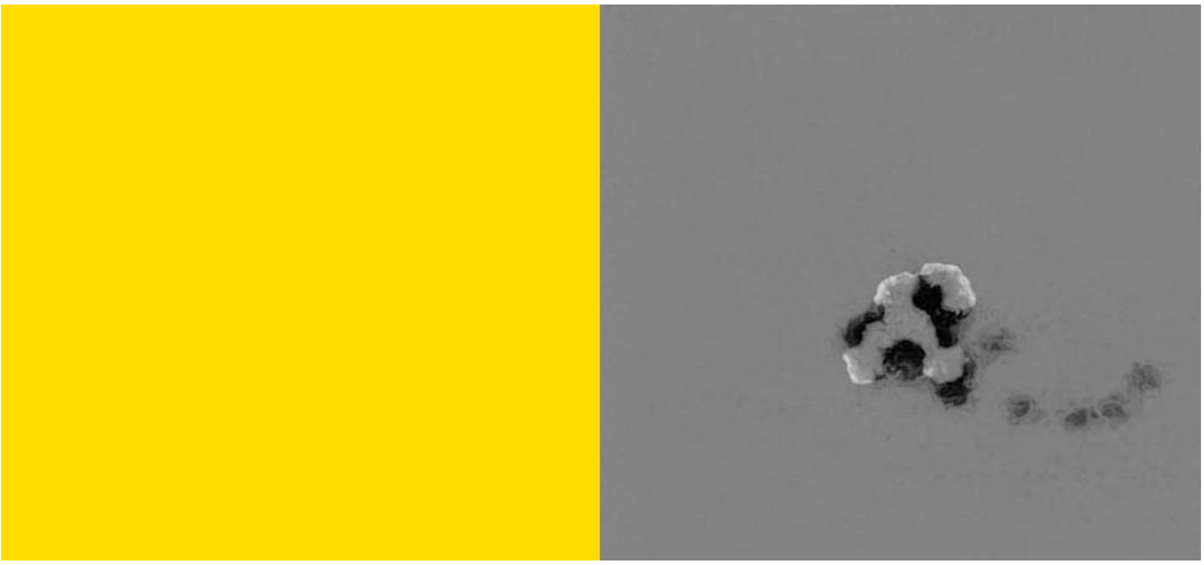
In both *Colourblind* (2011) and *Medium* (2011) the original source is removed and the building blocks are the stuff of the electro-biotechnical medium itself. In both these works the only source material is an undifferentiated field of colour.

In *ColourBlind*, a camera is turned on, covered with a modified Ganzfeld goggle [9], and bathed in a pure yellow light. The video stream is sent to a computer where the input is cropped and adjusted for fall-off at the edges of the camera so that the monochrome colour field is undifferentiated by tone or hue. The camera image is processed to construct a voxel volume that is analysed for optical features within a specified region of interest. Tiny inconsistencies in the colour field, invisible to the human eye, are tracked. These inconsistencies are amplified and rendered as pixels on a video plane that becomes increasingly densely populated through additive blending. Over time patterns gradually emerge as the analyses are accumulated and multiplied together. What starts as undifferentiated colour gradually resolves itself into patterns with structure and form.



ColourBlind, 2011

Medium takes this one stage further. A 120Hz colour field is generated by a computer, and is monitored for any changes in the pixel field. Removed from any optical input the field is stable and mathematically consistent from one frame to the next. Over hundreds of hours tiny inconsistencies in the field begin to emerge. As time passes these begin to change, growing or shrinking, developing momentary lives as active regions. The speed at which these form is extremely slow, and the attempt to track the emergence of these has resulted in little or nothing, and while perhaps this is an issue of insufficiently detecting thresholds of activity at such slow rates of change, it is tempting to speculate that it is the very act of observation that excites the electro-biotechnical field, and until there is an active observation the field remains perfect - empty and unchanged – that its manifestation is linked to a different consciousness, a different set of perceptual apparatus.



Medium, 2011

Medium, 2012

In seeing identity as a process rather than an object existing independently from other objects and selves, and suggesting that this process involves the perception of an observer who, through the act of perception becomes the initiator, Doppelganger, Medium and ColourBlind appear to mimic the processes of identity formation whilst at the same time suggesting there are unconscious experiences and liaisons with machines that are changing and transforming ourselves on a daily basis. In other words, we are not always aware of the processes and content of this 'transparent self-model". Identity is as much a product of the autonomic systems of the body interacting with technology that at the same time hides the intrinsic complexity of its own autonomic systems.[10]

The Project's recent works have at their core the notion that machine generated images are not now only fictional, but largely, and increasingly, hallucinatory. Built on a radically changing system of image production and reception what in the past can be seen as a consequence of the pareidolic impulse, is now complicated by the result of a symbiotic relationship between the deterritorialization of matter, the distributed mind and the resulting electro-biotechnical medium.

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10 www.research.ibm.com/autonomic/

Alec Groysman

Abstraction in Art, Science, Technology and Engineering

Topic: Art, Science and Technology

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http://www.wcjs.org/cv/groys/groys.html

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Abstract:
The aim of this study is to elucidate why *abstraction* is used correctly in science and is misused in modern art. The origins, history and meanings of the term "*abstraction*" are discussed in this paper. This term is used in different contexts and meanings: Abstract idea, abstract number, abstract quantity, abstract noun, abstract picture … Abstract art, abstract expressionism … From concrete to abstract … From abstract to concrete. The use of the term *abstraction* in the history of philosophy, science, mathematics, chemistry and figurative art is the same, but has different levels of abstraction. In all of these domains the meaning of abstraction is simultaneous elimination and generalization.
We can read *abstract* as *generalization* or *overview* of any research at the beginning of any paper. Scientists use *abstraction* correctly in their formulas and descriptions of various phenomena and reactions. Technologists and engineers also use *abstraction* properly in various processes and mechanisms. Unfortunately, since the beginning of the 20th century artists and art theoreticians often misuse this term because they reduce abstraction to simplification or elimination but without generalization. Hence, they frequently use the term *abstraction* in cases where it is absent. This was related probably to the explosion of development and inventions in science and technology at the end of the 19th – beginning 20th century. People of art wanted to understand and to describe their relationship to achievements in science, technology, and as a result in life. We should not confuse *abstract* with undefined, indefinite, open-ended, indeterminate, fantasy or conditional. May we connect *abstract* with *absurd*? How is *abstraction* related to *unconsciousness*? Examples of use the term *abstraction* in art (painting, sculpture, music, and poetry), science, technology and engineering are given. The misuse of the terms abstract, abstraction, abstractionism in art is analyzed in this study.

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Keywords:
Abstraction, art, science, technology, engineering

ABSTRACTION IN ART, SCIENCE AND TECHNOLOGY

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Premise. "*They want to show their education and always speak about incomprehensible things*."
"*Они хочут свою образованность показать и всегда говорят о непонятном*."
A. P. Chekhov (1860-1904), the Russian writer, the play "Wedding".

The aim of this study is the description of the origin and history of the term 'abstraction', its meaning in science and art, and metamorphoses of its connotation in the 20th century.
The term 'abstraction' is used in different contexts and meanings: abstract idea, abstract number, abstract quantity, abstract noun, abstract picture … abstract art, abstract expressionism … From concrete to abstract … From abstract to concrete… The use of the term 'abstraction' in the history of philosophy, science, mathematics, linguistics, and figurative art is the same, but has different levels of abstraction. In all of these domains the meaning of abstraction is simultaneous elimination and generalization. We can read this at the beginning of a paper: *abstract* as *generalization* of research. Scientists (e.g., mathematicians, physicists, and chemists) use 'abstraction' accordingly to its original meaning in their formulas and descriptions of various phenomena and reactions. Technologists and engineers also use 'abstraction' properly in creation of various processes and mechanisms. Since the beginning of the 20th century artists, art critics and art theoreticians often use the term 'abstraction' as a simplification or elimination but without generalization. Probably this happened because of the explosion of developments and inventions in science and technology at the end of the 19th – beginning of the 20th centuries. People of art wanted to understand and to describe their relationship to achievements in science, technology, and as a result in life. The change of meaning of the term 'abstraction' in art is analyzed in this study. Examples of use the term *'abstraction'* in art, science and technology are given.
Keywords: *abstraction, art, science, technology, education.*

1. Overture

« Art is something that stimulates the individual's thoughts, emotions, beliefs, or ideas through senses » [1].

Abstract idea, abstract thinking, abstract number, abstract quantity, abstract noun, abstract picture … Abstract art, abstract expressionism … From concrete to abstract … From abstract to concrete … One hears such combinations of words very often. The adjective 'abstract' stands before different words in their particular meaning.
I remember well how our teachers in my school and then in the university in the

former USSR (Union of Soviet Socialist Republics) criticized abstractionism and abstract art in 1950-1970s. All this was alien to us.
Two events caused me to carry out this study. The first event was in 1989 when I visited Sofia, the capital of Bulgaria, at the conference on corrosion of metals. I took my boss from Moscow to the National Art Gallery in Sofia. When we entered the hall of abstract paintings he cried and was outraged by them. These pictures really expressed nothing, only forms, lines, shapes, spots, and sometimes different colors.
It was by chance that it was a Bulgarian, Atanas Stoikov, who published a critical book of abstract art and its theory in 1964 [2]. The author dethroned the myth about ‘abstract art’ from the position of socialist realism and proved that this was not art at all.
I wanted to understand the paintings which expressed nothing. If these pictures are shown in museums, this means that there are people who like such pictures and can explain what this is, their meaning and value. My generation of 1960-1970s was educated on realism, namely, socialist realism – the official USSR art form. But Baroque and Renaissance paintings, classicism, romanticism, and impressionism were demonstrated in museums in Moscow, Leningrad and other cities in the former USSR. In any case, we were educated that any work of art must express some idea and reflect the real world.
The second event was in December 2011 during the 14th Generative Art conference in Rome, Italy. A young artist from Germany showed a picture and called it ‘abstract’ (Figure 1).

Figure 1. "1 to 2 to 3" 2011, (medium density fiberboard, a special wood material) and acrylic color [3]

In addition, the author compared his picture with abstract mathematical formulas [3]. We know well that mathematics is the most abstract science. I felt that the young artist put a different meaning of the term *abstract* than mathematicians. I decided to analyse what the term *‘abstract*’ means in art, science, technology, and engineering.
I was familiar with abstract paintings of Russian painters Wassily Kandinsky and Kazimir Malevich, the Dutch Piet Mondrian and Theo van Doesburg, the Frenchman Robert Delaunay, and the American Jackson Pollok. I liked some paintings by Kandinsky and Pollok (Figure 2), and did not like the pictures by Malevich, Mondrian and van Doesburg (Figure 3). For me, they expressed nothing. I explained my sympathy to paintings by Kandinsky and Pollok by aesthetics feelings: combination of colors and arrangement of forms, lines, particles, and different parts.
I understand that there are no quantitative criteria in art like in science. Our perception of works of art is based on the formula 'I like – I do not like'. In my opinion, any estimation of the work of art is subjective. But I wanted to understand why in any case there are people who enjoy a painting with very simple forms, lines and dots which are out of touch with reality. I feel that this probably depends on fantasy and the mood of a person.

a **b**

*Figure 2. **a** - Composition VII (1913) by Wassily Kandinsky; **b**- Autumn Rhythm (1950) by Jackson Pollok*

a **b** **c**

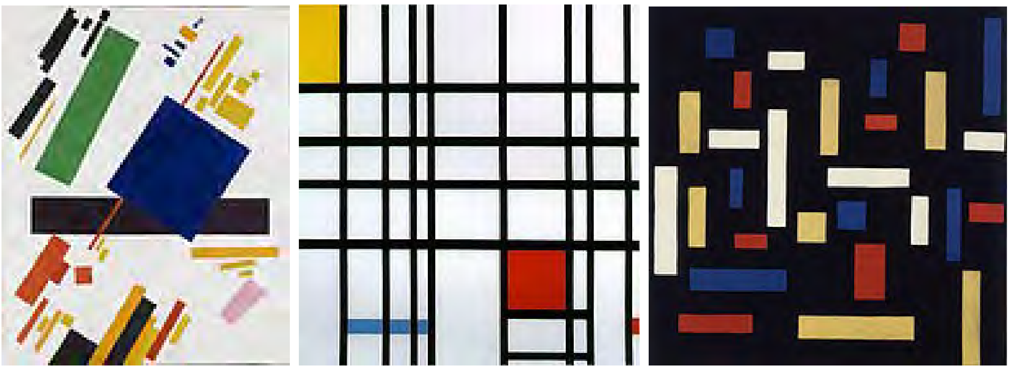

*Figure 3. **a** – Suprematist Composition (1916) by Kazimir Malevich; **b** - Composition with Yellow, Blue, and Red (1937–1942) by Piet Mondrian; **c** - Composition VII (the three graces) (1917) by Theo van Doesburg*

For instance, as in music when you listen for Bach`s fugue, Beethoven`s sonata or Chopin`s nocturne. This is called 'absolute (abstract) music' which is in contrast to the 'program music'. The latter reflects real picture or words. Listening to 'absolute (abstract) music', you may imagine anything that you want. This music does not reflect any actual word or world. Probably, like listening to 'absolute music' and enjoying the harmony of sounds, some people enjoy the harmony of colors, lines and forms by seeing 'abstract paintings' without any concrete particular picture in their brain …

Analysis of literature showed that there is serious research on this subject [2, 4-6]. A profound analysis of *abstract art* is given by the Israeli philosopher Tsion Avital in his book “*Art Versus Nonart: Art Out of Mind*” where he consequentially and strongly proves on 61 pages that *‘abstraction art*’ of the 20th century is not *‘abstract*’ and is not *‘art*’ [4, pp. 167-228]. Why in spite of these profound works and books, people continue confusing terms concerning ‘abstract’ and its derivatives? In order to reply to this question, we should analyse the history of the origin and meaning of the term ‘abstract’.

2. Definition of the term ‘abstract’

Probably the first who introduced the idea of the process of abstraction in explaining the source of human knowledge was the Greek philosopher Aristotle (384-322 BC). He explained that human beings are born without any ideas in their minds. Man only knows through the process of abstraction of the essences of particular things and forming them into universal ideas [7]. For instance, all red things are similar in that there is the same universal, redness, in each thing. When we form the concept of a universal on Aristotle's theory, we ‘abstract’ from a many instances we come across. Aristotle used the Greek words *aphaeresis* (taking away from a thing, elimination, diminishing) and *korismos* (separation, dividing). We as it were mentally extract from each thing the quality that they all have in common. So how does the little girl get the concept of a human being? She learns to ignore the details, tall and short, black and white, long hair and short hair, male and female, etc.; and she pays attention to the thing that they all have in common, namely, humanity. In Aristotle's view, the universal humanity is the same in all humans (i.e., all humans have that exact same type in common); and this allows us to form a concept of humanity that applies to all humans.

Abstraction is a philosophical process by which people develop general concepts from experience. Abstraction is the process of *drawing out* (*elimination, separation*) the essence of things and giving them independent existence from the things of which they are inextricably connected. For instance, when we use the generic term animal we have merely extracted the essence of all animals (bear, dog, or wolf) and have made it to stand for the general idea of collectivity of animals.
In other words, *abstraction is a simultaneous elimination and generalization.* Let us open any scientific journal. Each article begins with an *abstrac*t, meaning *summary, synopsis, elimination*, *generalization*, *or quintessence*. Thus the noun *'abstract'* is used for a summary, compendium or epitome of a larger work, the gist of which is given in a concentrated form [8]. *Abstraction is the opposite to concrete, detailed*.

Probably, the Roman scholar and philosopher Anicius Manlius Severinus Boethius (480 - 524 AD) was the first who translated the terms *aphaeresis* and *korismos* used by Aristotle (800 years later!) from the Greek into the Latin words *abstractio* and *abstrahere* [9]. These Latin words were adopted in other European languages. Did people use these terms during the next 15 centuries until the beginning of the 20th century? Nobody knows. These Latin words *abstractio* and *abstrahere* “*have misled many, especially in the world of art, to think that abstraction is only separation*.” [4]

What happened in the 20th century? What is written about *abstraction* in different dictionaries and encyclopedias published in the 20th century? “*Abstraction is a mental distraction from the object, its properties or signs, which really cannot exist separately by itself*” [10, p. 9]. This was published in 1907 in Russia. This date is very important because the beginning of the modern abstract art is credited to Russian painters Wassily Kandinsky and Kazimir Malevich in 1910-1015. I can only suggest that these painters read the famous encyclopedia by Brokgauz and Efron [10]. A similar definition *of 'abstraction'* was given in the Encyclopedia Britannica in 1911 [11].

Then we read in the vocabulary of foreign words published in the former USSR in 1964 [12, p. 12]: "*Abstract is distracted (disengaged); Abstractionism, abstract art is extremely formalistic direction in painting, sculpture and graphics (drawing), originated and developed in the 20th century; abstractionists deny realism completely, their works represent a meaningless combination of distracted geometric forms, chaotic spots and lines*". The next word defined in this vocabulary was "*Abstraction derived from the Latin 'abstractio' (elimination, distraction) - a) mental distraction from sides, properties or relationships of subject; b) distracted idea, concept or theoretical generalization …*" [12]. The next word in this vocabulary was *absurd*. Was not this symbolic? I found similar definitions of the term *abstraction* in the Soviet Encyclopedia (1983), even more, that "*abstract is opposite to concrete"* and *"some currents of abstractionism (suprematism, neo-plasticism) having something in common with the seeking and striving for architecture and industrial art design created ordered constructions from lines, geometric figures and spaces; others (tashism) seek to express spontaneity and unconsciousness of creativity in dynamics of spots and spaces*" [13, p. 10].

Now I understand that this was a mixture of correct and wrong definitions of terms *abstract*, *abstractionism* and *abstract art*.

3. Change the meaning of the term *'abstraction'* in art

Abstract art in this original sense has existed for many years, probably since prehistoric times [4, 2]. There can be no doubt that a new meaning of abstract art was introduced by Russian painters Wassily Kandinski [14] and Kazimir Malevich [15, 16]. They or art theoreticians and critics misused these terms, probably, because of the wrong translation of the term *abstract* into the Russian language. One of the translations of the word *abstract* into Russian was *'otvlechenni'* (отвлечённый, воображаемый, умозрительный) - *distracted (disengaged, discrete, notional)*. In this sense, any form, line, space, dots can be present in accordance with a fantasy and a mood of an artist. And any observer can imagine any object (real or unreal) according to his mood and fantasy looking at such an 'abstract' picture, similar to a listener of Chopin`s nocturne. Thus, we encounter a situation in which the original meaning of the word (*'abstract'* in this case) was changed. This was not the first time in history. Really we encounter the situation when one word (*abstract*) acquired several meanings. For instance, the word *fields (polya* - поля) in Russian has three meanings: the area of soil with agricultural product, round ends of a hat or margins on a page. Its meaning depends on the context.

Etymology, as the study of the history of words, their origins and how their meaning have changed over time, is very important in this case, because an unexpected transformation of primary meaning of words with time can give an interesting but not always useful knowledge. For instance, the word '*calculus*' means '*pebble*' (in Latin), as Pythagoreans (the Greek mathematicians) used pebbles before the invention of figures, and certainly this cannot help in understanding the mystery of algebra [17]. Knowledge that word '*classic*' in Latin meant '*fleet*' and then meant '*order*' also cannot help in understanding modern meaning of word '*classic*' [17].

Capricious changes of a meaning, often from the original quality to its very opposite, follow a perfectly obvious principle: a word designates any quality that can symbolize a certain feeling [6]. An American philosopher of art Susanne Katherina Langer (1895-1985) lists several examples of changes of original meanings of colors. For instance, the word *blue*, German *blau,* derives from *blavus,* a Middle Latin form of *flavus*, meaning, not *blue*, but *yellow* [6]. It is explained by the fact that colors were not always distinguished by their actual spectral values (red, blue, etc.), but primarily as warm or cold, clear or dull. This is correct because these words symbolize opposite sensations or feelings and relate to metaphors. We can hear: cold tone or warm color. The Russian painter Wassily Kandinsky (1866-1944) analyzed colors in a similar manner [14]. Thus, a poet can say instead of *white – black*, metaphorical equivalents *warm - cold, clear – vague,* etc. This depends on our imagination and perception, because somebody can imagine definitely opposite that *white* is *cold* (like *snow* or *ice*) and *black* is *hot* (like *black hole* or *hell*). This happens because we deal with *qualitative values*.

Why has it happened that the meaning of the word *'abstraction*' was changed in art in the 20th century from its original use, sense and connotation (*elimination-generalization*)?

I will try to give my vision why 'abstract art' and other modern artistic movements appeared at the beginning of the 20th century. We can use one of famous dictum that development of science and technology takes place but "*there is no progress in art*" [18, p. 10]. Significant achievements were done in science and technology in 1895-1910s. Let me mention only several considerable achievements: the production and detection of electromagnetic radiation (known as X-rays or Röntgen rays) by the German physicist Wilhelm Conrad Röntgen in 1895; the discovery of radioactivity by the French physicist Antoine Henri Becquerel in 1896; the discovery of electrons by the British physicist Joseph John Thomson in 1897; the introduction of quanta (photons) by the German physicist Max Planck in 1900; the theory of relativity by Albert Einstein in 1905 which changed views on space, time, and matter; the formulation of the model of the atom by the British physicist Ernest Rutherford in 1911. Then the works on psychoanalysis by the Austrian psychiatrist Sigmund Freud, the production of automobiles, the first flights by airplanes, etc.

These discoveries and developments in science and technology of course influenced people, their life, thoughts, and psychology. All this could not influence the artistic world. Artists tried to understand these changes and to reply by their works. For instance, French artist Marcel Duchamp (1887-1968) suggested artistic version of "denuding" of matter (after discovering of electron) in his paintings "*The King and Queen Surrounded by Swift Nudes*" and "*Nude Descending a Staircase*" (Figure 4). Duchamp attempted to give visual form to the invisible world in his paintings [19, 20].

Artists sought progress in the field of art and suggested their vision of new phenomena. Thus artists began "destroying" old art in the hope to create something new in accordance to changes of knowledge about our material world. Futurism, cubism, fauvism, Orphism, expressionism, Dadaism, and surrealism in painting; functionalism and constructivism in architecture; symbolism and zaum (Russian 'заумь' – 'transreason, transration or beyondsense') in poetry; and dodecaphony (atonal music) in music appeared. We can call all these movements by one word *avant-garde*.

a **b**

Figure 4. Marcel Duchamp (1912). ***a*** *– "The King and Queen Surrounded by Swift Nudes";* ***b*** *– "Nude Descending a Staircase"*

The latter is the French word meaning *advance guard* referring to people or works that are innovative or experimental, particularly with respect to art and culture. *Avant-garde* represents a pushing of the boundaries of what is accepted as the norm or the status quo, primarily in the cultural realm. The French banker and mathematician Olinde Rodrigues (1795-1851) first used the term *'avant-garde*' in his essay "*The artist, the scientist and the industrialist*" (1825), in which he called artists to «*serve as [the people's] avant-garde*», insisting that «*the power of the arts is indeed the most immediate and fastest way*» to social, political, and economic reform [21]. Over time, avant-garde became associated with movements concerned with "Art for art's sake", focusing primarily on expanding the frontiers of aesthetic experience, rather than with wider social reform.
We should mention that art has different aims: the reflection of real material and spiritual world, bringing pleasure (hedonistic function), communicative (the ability of art to carry out communication between people), cognitive (education) function, and aesthetic (the creation of beauty) [22]. I would like to put in the first place the *creation of beauty*. Thus the Russian writer Leo Tolstoy emphasized the ability of art to ensure the communication between people, the German philosopher Georg Hegel – possibility to comprehend the *'absolute'* by means of art, Sigmund Freud saw in art getting rid of neuroses [22, p. 38]. Thus each person chooses in art something important for him. This approach to art explains acceptance, delight and admiration (or hostility) by paintings of 'abstract' art.

4. Real abstract art is not undefined or ambiguous

You can often hear that 'abstract' art is vague, uncertain and indefinite and leaves the viewer to decide what it is. Susanne Katherina Langer began her manuscript written 55 years ago with the sentence "*all genuine art is abstract*" [6]. Then she continued: "The *schematized shapes* usually are called *abstractions* in painting and sculpture". Schematized is not undefined or ambiguous. Schematized is generalized, universal, common, collective, and comprehensive. Thus *schematize*d is opposite to *concrete*. Look at a woman or a man painted on the doors of public toilets. All these paintings are *abstract* because they are *schematized*, reflect all women and all men and not some specific Marie or John, a person of specific age, origin, nation, weight, height, volume, color, smell, etc. If you see a picture with the title "Untitled" in a museum it does not mean that this is abstraction. If any form, shape, line, or scramble depicted on the list may be 'abstract' this means that any person, animal, machine can be an "artist". A real *abstract painting* or an *abstract sculpture* is a generalized quintessence of some concrete forms. *Abstract* must be concise and recapitulative. An abstract painting or an abstract sculpture consists of forms or shapes, but the opposite is false. Not any form and shape may be abstract.

Not all books on art distinguish *abstractionism* as individual art movement or style. For instance, in chronology of 50 "Isms" during the last 700 years in 1300-2005 *abstractionism* (as art!) is not mentioned at all [23]. But *abstract expressionism* and *suprematism* are mentioned. The latter movement was developed and led by the Russian artist Kazimir Malevich (1878-1935). Suprematists believed they could express themselves through *geometric abstraction* [23]. Even this combination of words deluded (lead into error). *Suprematism* and *abstract expressionism* were invented and defined by artists themselves. They put another sense and meaning which were originally in the term *'abstract'*. Such a situation brought misunderstanding in next generations of artists, art critics, art dillers, and wide lovers of art. We should agree that in the best case the paintings of Russian painters Wassily Kandinsky (1866-1944) ("Without name", 1910), Kazimir Malevich ("Black Square", 1915), El Lissitzky (1890-1941) ("Proun 19D", 1922), and a Dutch painter Piet Mondrian (1872-1944) (grid-shaped paintings) may be named *graphical design* [4, p. 240] (Figures 5, 6). They were marked as *modernism* or *neo-plasticism* [23] and not as *abstractionism* (in the term of art). Thus all these movements (*suprematism*, *modernism*, *neo-plasticism*, etc.) were the reduction of painting to a code of shapes, forms, lines and colors in spite of attempts to explain that this is a new language of painting.

Probably owing to works of Ernst Linde [24] and a German art historian Wilhelm Worringer [25], the term 'abstract' entered into art and aesthetics in 1907-1908. Worringer argued that there were two main kinds of art: art of 'abstraction' (which was associated with a more 'primitive' world view) and art of 'empathy' (which was associated with realism in the broadest sense of the word and applied to European art since the Renaissance).

Some of the foundations of 'abstract art' (Malevich, Kandinsky) tried to explain and ground their destruction of old art and creation new one as *abstraction*. Certainly they [14-16] and art historians [25] used wrongly this term *'abstraction'* in its original meaning *elimination* and *generalization*. But … if to use the Russian word *'otvlechenni'* (отвлечённый) - *distracted (disengaged)* as translation of 'abstract' into Russian, their paintings really were *distracted (*отвлечёнными*)*.

Let us address the original works "About spiritual in art" (1910) by Wassily Kandinski [14] and "From Cubism to Suprematism" (1915) by Kazimir Malevich [16]. Malevich was not a pioneer of *geometric abstract art*. It is important to emphasize that after the creation of the work of art it does not belong to the creator, and you may speculate what you want. For instance, you can read that «*Malevich was interested in aerial photography and aviation, which led him to abstractions inspired by or derived from aerial landscapes*» [26]. Some Ukrainian authors claim that Malevich's suprematism is rooted in the traditional Ukrainian culture: «*His abstract visual language and non-objective (non-figurative) art called suprematism (which he invented in 1915) drew on the simple values of peasant life and was rooted in the simple values and aesthetics of peasant folk*» [27, 28].

a **b**

*Figure 5. **a** - Wassily Kandinsky, "Without Name" (The 1st Abstract water color on paper), 1910. **b** - Kazimir Malevich, "Black Square", 1915*

a **b**

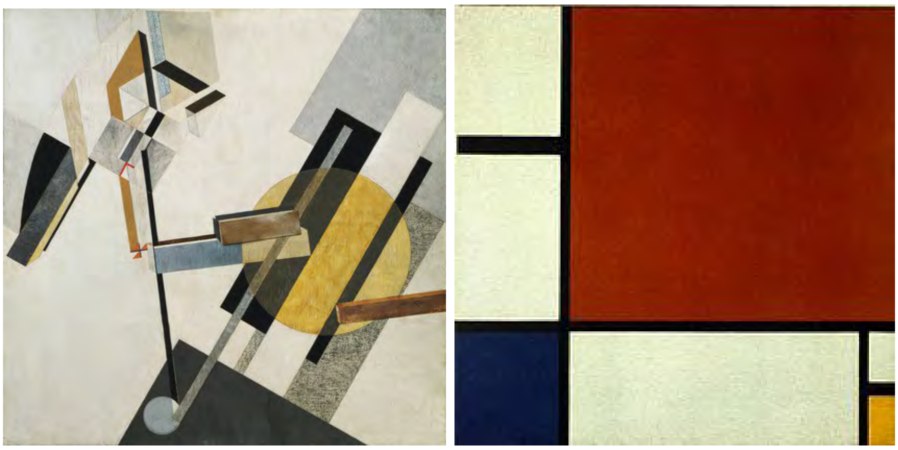

*Figure 6. **a** - El Lissitzky, "Proun 19D", 1922. **b** - Piet Mondrian, "Composition II in Red, Blue, and Yellow", 1930*

The American Asian artist and art scholar Stephen Little suggested the key concepts, styles and issues relating to such *ism*: *suprematism* of Malevich was named as *geometric abstraction, monochrome, assault, spiritual purity, or spatial movement*; *neo-plasticism* of Mondrian was named by *grids, spiritual order, and elementarism* [23].
What did Malevich say about his paintings?
All explanations made by Kazimir Malevich or Piet Mondrian failed because there is no mind line which can be understood by each "middle" person. Kazimir Malevich did not use the term *abstract* from the beginning, but *suprematism* deriving from *suprématie* (in French, and not *suprême*) which means *priority* (*supremacy*) of color problem [15, p. 90]. Taking into consideration the Polish origin of Malevich it is possible that he invented *suprematism* from the Polish word *supremacja* which is similar to the French word *suprématie* and means *superiority, predominance, prevalence, supremacy, domination* [15, p. 179]. Malevich begins his theoretical papers in 1915 with a clear thesis of destruction of *old art*: "*All old and modern painting before suprematism, sculpture, word, and music were enslaved by a form of a model and are waiting of their liberation, in order to speak in its own language and*

do not depend on mind, reason, meaning, logics, philosophy, psychology, different laws of causality and technical measuring of life" [15, p. 191]. Malevich writes later: "*Overthrow of the old world of art will be written on your palms*" [15, p. 201]. Theory of *pointless art* creating by Malevich from 1915 was spread on all kinds of creative works such as painting, poetry, and music [15, 16]. Syncretism (combination) of different arts confessing by Malevich was related to symbolism of the beginning of the 20th century. He used definitions *pointlessness* (without matter, without content), *pointless art* (art without content, matter) and wrote about "*suprematism as pointless new pictorial realism"* [15, p. 216]. Malevich wrote that "*suprematic forms as abstraction became utilitarian perfection*" [15, p. 233]. In other words they (forms) expressed nothing, zero. Malevich wrote about the world as *pointlessness* and called his suprematism by *pointless – abstract art* [15, p. 306]. He left behind large theoretical works which are full of a mixture of interesting thoughts and allogisms. We can conclude from his works that he did not use *abstract* in its original meaning *(elimination*, *generalization*) but in the sense of *otvlechenni* (отвлечённый, воображаемый, умозрительный) - *distracted (disengaged, discrete, notional*).

In all the movements of figurative painting of the 20th century, the main component of painting was lost and was absent – *mind*. This was explained by Israeli philosopher of art Tsion Avital [4] and partly by Ukrainian-Jewish scientist Vladimir Koshkin [5]. Vladimir Koshkin describes an *abstraction as a summary* on the example of Picasso`s series of 11 pictures of bull (Figure 7):

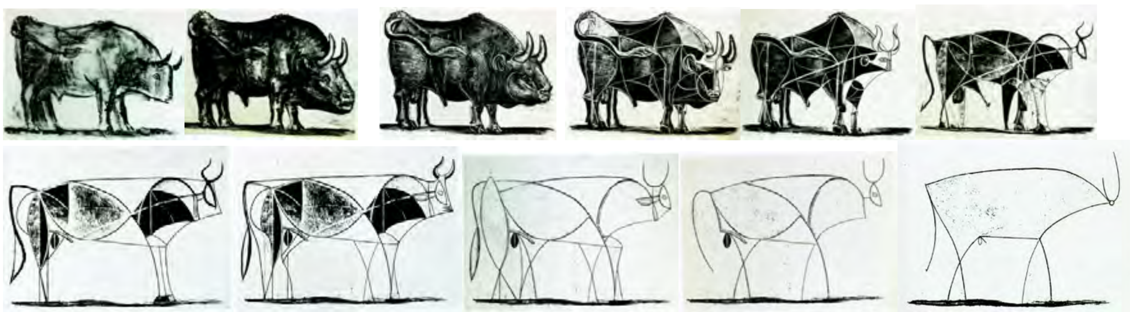

Figure 7. Picasso`s bulls (the example of genuine abstract art)

«*Picasso begins from a nearly photographic picture of a bull – with black nostrils, with felt hairs … Part of details has been already removed on the third drawing – this is still a "portrait" of the concrete bull but a little bit generalized. A bull does no longer smell. Consecutively removing details, Picasso concludes with a symbolic portrayal of "a bull in general" on the last drawing. This is a figurative explanation of the origin of 'abstraction' in modern art. But this picture is similar to a portrayal of animals in the caves done many thousands years ago. Primitive people began from symbols! Primitive people were not yet interested in the "individuality" of an animal – this is a source of meat for food or a source of danger. Primitive artists were "symbolists" in the context of abstract meaning "non-detailed". People of the stone epoch began artistic (and scientific!) understanding of the world from such abstractions. They were the first "formulas" and equations. Similar to modern road signs but in the times when symbols as generalizations and designations of meanings have been just engendered. Symbolic drawing is simpler than "realistic" (technically) picture but this* *is quite another matter. Symbolic drawing is more informative than detailed picture: it is remaking information conveniently summarized and gives the opportunity for quick perception and effective acceptance of life decisions. Of course, the quantity of bites (according to the information theory of Claude Shannon) is much more in "figurative" depiction of the bull, but his abstract portrayal gives more such information which will be fixed by our memory – especially during the limiting time of acquaintance and looking at the "portrait" of this character. Particularly if the "personality" of a bull is not interesting for me, but I would like recognize it earlier before I run into in the field. An efficiency of memory and further recognition of generalized portray is more than that of a detailed one. This is a paradox of lack of coincidence between "amount" and "value" of information*» [5, pp. 36-37].

Certainly this *real abstract painting* of bulls by Picasso differs from 'abstract' painting by Kandinsky, Malevich and others. Sometimes art theoreticians say that in order to understand new modern 'abstract' art you should learn the principles of art. Thus we come across with some questions. For whom are the 'abstract' paintings intended? Should a person know the principles and basics of painting in order to understand and enjoy pictures? This question probably is similar to the following questions. Should we know the notes and chords in order to enjoy music, or should we know the principles of linguistic and phonetics in order to understand the language which we speak? There is no unequivocal reply.

5. Resume (for Abstraction in Art)

When you listen to "The Dance of the Swans" from the ballet "Swan Lake" by Russian composer Pyotr Ilich Tchaikovsky it is difficult to imagine something else. Tchaikovsky wrote this composition when he observed the swans on the lake in Germany. If Tchaikovsky did not give the name to his composition, what would you imagine? Music creates mood. I feel that many musical descriptions of the dance of the swans can exist. Something similar exists in painting. A painter can create many different compositions with the title "Loneliness": a tree or a person in isolation, etc. A composer generalizes by means of different combinations of notes. A painter generalizes by different compositions of colors, forms and lines.

Probably *abstract art* which was coined to some painting movements in the 20th century is similar to attempts of creation of international language based only on some stochastic and meaningless sounds. For many people who try to understand and enjoy *'abstract' art* this is similar as they enter a country with a language unknown for them. We know that words consist of letters, but not any combination of letters will give words. Music consists of sounds, but not just any combination of sounds gives music.

What was lost in *abstract art* of the 20th century? Some rules of organization, order and of combination of colors, forms, lines, sounds, and letters.

Now we will describe abstraction in science and technology.

6. Abstraction in Science

Science is an enterprise that builds knowledge about the universe. Science is the systematic attempt to discover and expose nature's patterns. In short, science appeared as satisfaction of curiosity of people [1].

The driving principle of science is generalization. Its subject matter is really something perfectly concrete, namely, the physical world. Its aim is to make statements of utmost *generality* about the world. In order to create real abstraction we should first eliminate and then generalize. This is exactly that is made in science and technology. Abstraction gives the opportunity to create powerful symbols which may be understood by any person.

Any formula in physics, any written chemical reaction in chemistry, most graphs in thermodynamics and corrosion science are abstraction. For instance, the dependence of corrosion current on electric potential for some concrete system (for instance, iron in aqueous solution of potassium sulphate or nitric acid) can be summarized as a generalized graph (Figure 8).

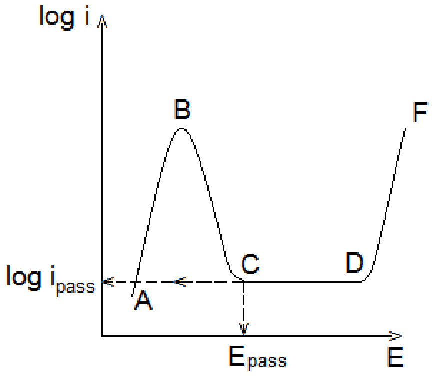

Figure 8. Anodic polarization curve of metals/alloys possessing passive state:
***E**, Volt (electric potential); **i**, A·cm^{-2} (electric current density) [29]*

Many metals and alloys, in certain liquid media, behave in this manner and this generalized graph shows that metals/alloys possess a passive state. This *abstract* graph (see Figure 8) has great practical value and application.

Only photography can show a real picture. When a painter creates his painting of some natural object he makes an abstraction from the concrete matter. In science the situation is similar. When studying concrete material or a specific process, scientists make generalizations. I will describe several examples of such abstractions from physical chemistry.

1. Studying the dependence of air volume on pressure, the French scientist Benoît Paul Émile Clapeyron (1799-1864) suggested in 1834 the equation of state of <u>any</u> hypothetical ideal gas (ideal gas law), not for some particular gas but for all ideal gases (1).The state of an amount of <u>any</u> gas is determined by its pressure, volume, and temperature.

$$PV = nRT \qquad (1)$$

where P is the pressure of the gas; V is the volume of the gas; n is the amount of substance of gas (for example, the number of moles); T is the temperature of the gas; and *R* is the universal gas constant. Any gas irrespective of its composition (hydrogen, oxygen, helium, etc.) at low pressures or high temperatures behave in a similar manner and this behaviour is described by the generalized (abstract!) equation (1).

2. In order to determine the direction of <u>any</u> physico-chemical process (chemical reaction or change of state of a matter) you can use the Gibbs–Helmholtz equation (2).

$$\Delta G = \Delta H - T \cdot \Delta S \qquad (2)$$

where ΔG is the change of Gibbs energy; ΔH is the change of enthalpy; ΔS is the change of entropy, and T is a temperature. Thus the generalized (abstract!) equation (2) is related to all physico-chemical processes irrespective of their nature.

3. The Arrhenius equation (3) describes the dependence of the rate of <u>any</u> chemical reaction on temperature:

$$\ln k = \ln A - E_a/RT \qquad (3)$$

where k is the rate constant of chemical reaction; A is the pre-exponential factor; E_a is the activation energy, R is the universal gas constant, and T is the temperature. Thus the generalized (abstract!) equation (3) is related to all chemical, biochemical and many other thermally-induced processes/reactions irrespective of their nature. Certainly every formula in physical chemistry is the generalization of many particular processes.

Thermodynamics deals with *abstract* (*generalized*) processes. For instance, you observe water in a puddle (Figure 9).

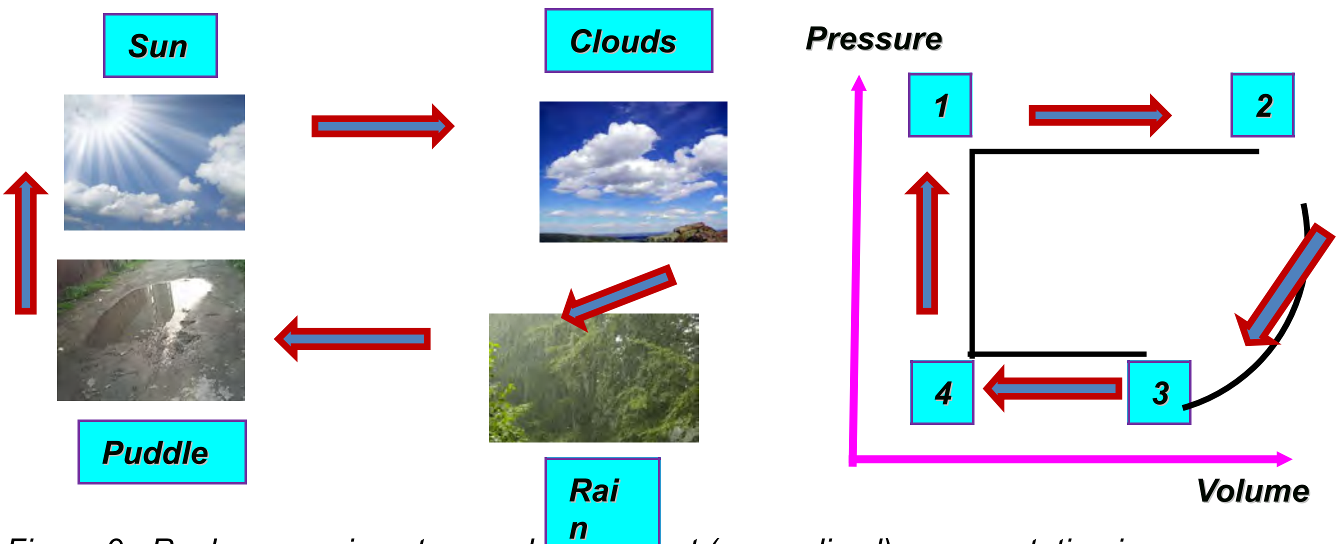

Figure 9. Real process in nature and its abstract (generalized) representation in thermodynamics by the graph 'pressure – volume' (description is in the text)

The sun is shining and water is evaporating. Thus, the volume of water increases at constant pressure: process 1-2 in the diagram 'pressure – volume'. Then clouds are formed from water vapor. Thus, pressure and volume of water vapor decreases: process 2-3. Then rain is formed from the water vapor. The volume of water vapor drastically decreases (it is rain): process 3-4. A puddle is formed and sun rays heat water to original pressure: process 4-1. In thermodynamics all this is generalized as an abstraction in the 'pressure – volume' diagram. Water in the puddle, sun, clouds and rain disappear from the 'pressure – volume' diagram since it is not important. Thus all similar processes in nature and industry are described with such a graph. Thus we showed the power of ‘abstraction’ which is a real generalization of many chemical and physico-chemical processes.

4. Here is an example from materials science. The Israeli scientist Dan Shechtman detected quasiperiodic crystals in 1982 when studying the particular alloy titanium aluminide by means of an electron microscope. A quasiperiodic crystal (shortly, quasicrystal) is a structure that is ordered but not periodic, namely, which has a forbidden symmetry of five (Figure 10).

a **b**

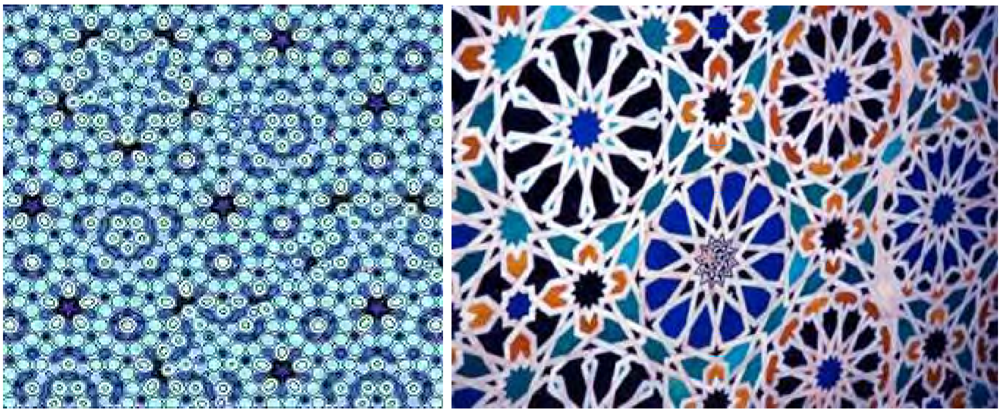

Figure 10. ***a*** *- Atomic model of an aluminium-palladium-manganese (Al-Pd-Mn) quasicrystal surface [30];* ***b*** *- Mosaics, which are not periodic are found in the medieval Islamic mosaics of the Alhambra Palace in Spain [31].*

Dan Shechtman received the Nobel Prize in chemistry 2011 for this discovery. Since the original discovery by Dan Shechtman, hundreds of quasicrystals have been reported and confirmed. Thus, the quasicrystals are no longer a unique form of solid; they exist universally in many metallic alloys and some polymers, even in nature. Nowadays we can say that a quasicrystal is a generalization of a large group of artificial and natural crystals and its representation is found even in art (ornaments). Aperiodic mosaics, such as those found in the medieval Islamic mosaics of the Alhambra Palace (Spain) and the Darb-i Imam Shrine (15th century, Isfahan, Iran), have helped scientists understand what quasicrystals look like at the atomic level. In those mosaics, as in quasicrystals, the patterns are regular - they follow mathematical rules - but they never repeat themselves (see Figure 10).

7. Abstraction in Technology

Technology is the conversion of natural resources into tools for the satisfaction of needs and requirements of people [1]. Let me give some examples from everyday life.

1. You drive a car which operates on a gasoline or diesel engine, named also a heat engine. All these heat engines are powered by the expansion of heated gases. A heat engine is a system that performs the conversion of heat (thermal energy) to mechanical work. A brilliant example of abstract vision

presented by the French engineer and scientist Nicolas Léonard Sadi Carnot (1796-1832) in 1824 is the ideal Carnot cycle which scientifically clearly explains the work of any steam engine. Using an abstract way of thinking Sadi Carnot wrote in his book "*Reflections on the Motive Power of Fire*" that «*it was necessary to establish principles applicable not only to steam-engines but also to all imaginable (meaning abstract) heat-engines*». Of course, there were no automobiles in that time, but many ships worked on such heat engines. Carnot analysed a *generalised* heat engine, suggested the cycle and another French scientist Clapeyron later built it in a graphical *generalized* (*abstract*!) form 'pressure – volume' (Figure 11).

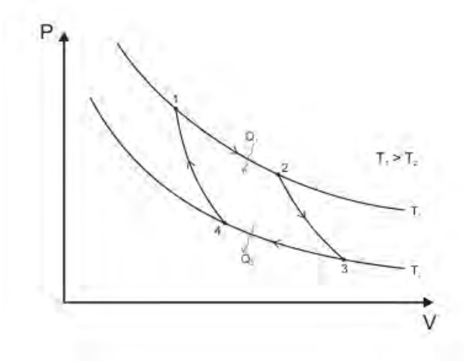

Figure 11. A Carnot cycle illustrated on a 'pressure-volume' (P-V) graph explaining how any (generalized or abstract) heat engine works

This is classical generalization (abstraction) of all ideal heat engines.

2. Here is another example. You use gasoline or diesel fuel in your automobile. How are they produced? The process of producing of fuels from crude oil is called *distillation*. Distillation is a method of separating a liquid homogenous mixture into fractions based on differences in boiling points of its components (Figure 12).

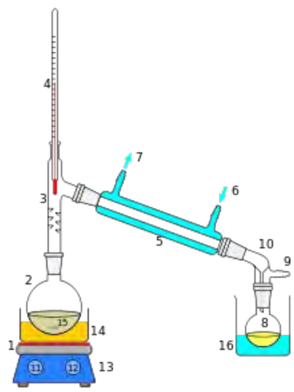

Figure 12. Laboratory display of distillation

It does not matter which liquid mixture is distilled. You may distill crude oil into fuels, salt water and receive pure (distilled) water, fermented aqueous solutions and produce alcohol beverages, liquid air and produce pure oxygen and nitrogen, ordinary water and produce 'heavy' water, liquid hydrogen and produce deuterium (heavy isotope of hydrogen). Thus distillation is a generalization of physical process of separation of any liquid homogenous mixtures. This generalization (abstraction!) helps the chemical engineer to calculate parameters needed for separation and producing pure components.

8. Abstraction and Expression

Any representation in memory is a sum, an integrative mixed image. Try to imagine any picture or phenomenon that you observed in nature, in a museum, or in a theatre. Try to recollect some details, and I think that this is not simple. We have difficulties of *expression* of some dynamic image which was received through *perception* including organs of sense, mood, spiritual condition, emotion, etc. Thus we want to *express the abstract* of image (generalized picture). As a result *abstract expressionism* developed by Jackson Pollock appeared: «*I want to express my feelings rather than illustrate them*» [32]. Is this an art? Let me cite Vladimir Koshkin: «*I do not understand and do not feel what Pollock wanted to say in his colour pictures under different numbers. Art however addresses not only feelings but also understanding*» [5, pp. 39-40]. Then Vladimir Koshkin concludes with a similar sentence as an epigraph to the book [4] by Tsion Avital: «*Delights of people before the "Black Square" by Malevich are seemed by exclamations of citizens from the tale "The Emperor`s New Clothes" by Hans Christian Andersen*». Both Tsion Avital and Vladimir Koshkin conclude that "*art is combination of feeling and intellect (mind)*" [4, p. 15; 5, p. 40]. You may read the same in the epigraph in the 'Overture' (beginning of this paper). In any case why do I personally and many people like some pictures by Jackson Pollock (Figure 13)?

Figure 13. "Number 5" (1948) by Jackson Pollock

9. Art and Brain

Mathematics explained the art of Jackson Pollock and why people enjoy his paintings [33]. Mathematics showed that Jackson Pollock's famous drip paintings are fractals. Fractals are complex geometric shapes that have been studied by mathematicians since the 1970s. The term 'fractal' was first used by the French

American mathematician Benoît Mandelbrot in 1975. Mandelbrot based it on the Latin ‘frāctus’ meaning ‘broken or fractured’, and used it to extend the concept of theoretical fractional dimensions to geometric patterns in nature (Figure 14). Clouds are not spheres, mountains are not cones, and lightening does not travel in a straight line. The complexity of nature's shapes differs in kind, not merely degree, from that of the shapes of ordinary geometry, the geometry of fractal shapes [34, 35].

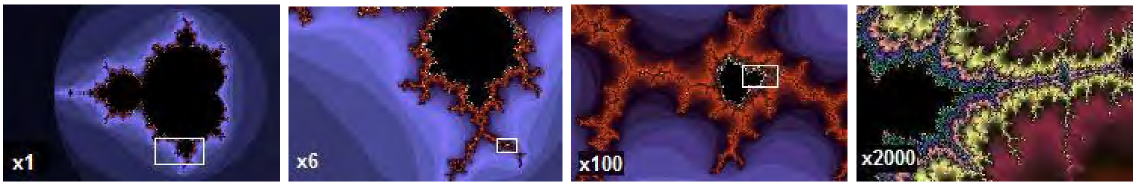

Figure 14. The Mandelbrot set illustrates self-similarity. As you zoom in on the image at finer and finer scales, the same pattern re-appears so that it is virtually impossible to know at which level you are looking [35]

Fractal analysis can be used to distinguish Pollock's drip paintings from imitations. The American scientist Kate Jones-Smith showed that doodles that she could make in minutes using Adobe Photoshop were as fractal as any Pollock drip painting, vividly refuting the physicist Richard Taylor's claim that Pollock was able to generate fractals by hand only because he had attained a mastery of chaotic motion. A defining feature of fractals is their self-similarity. They look the same if magnified. Sometimes the self-similarity is visible to the eye, as in the famous Koch snowflake, which is composed of a hierarchy of ever smaller equilateral triangles. The Koch snowflake (also known as the Koch star and Koch island) is a mathematical curve and one of the earliest fractal curves to have been described [36] (Figure 15).

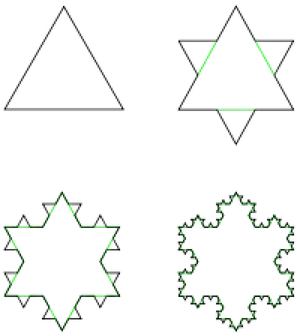

Figure 15. The first four iterations of the Koch snowflake [37]

It is based on the Koch curve, which appeared in a 1904 paper titled "*On a continuous curve without tangents, constructible from elementary geometry*" by the Swedish mathematician Niels Fabian Helge von Koch. More often the self-similarity is statistical and can be detected only by computer analysis using a technique called box-counting. Fractal analysis involves placing a grid over an image to search for replications of geometric patterns. In this case, it also involved colour separation and an analysis of each layer of paint. The data is plotted on a graph and a “box-counting curve” that resembles a staircase is generated. This curve is inspected to see if it meets the fractal authentication criteria [38].

It is obvious that art is transformed in our brain. Neurologists entered this field to understand what happens in the brains of artists and lookers [39-41]. Neurology is the medical specialty related to the human nervous system. The nervous system encompasses the brain, spinal cord, and peripheral nerves. According to an English scientist on neuroesthetics Semir Zeki, « …*most painters are also neurologists*» [39]. American psychologist Patrick Cavanagh talked the same about «*the artist as neuroscientist*» [40].
Israeli scientist Idan Segev explains why many people like some pictures by Jackson Pollock. "*What is there in the human brain that takes pleasure in ar*t?" [42]. Once more, his technique consisted of spraying, dripping and pouring paint on canvases (see Figure 13). His works are constructed of particles, which are mathematical expression of a geometric form that is composed of copies of itself. In other words, even when you look at only a part of it, you see the whole picture [42]. A particle refers to coverage of a surface with paint that is measured on a scale between 1 and 2. This is the *fractal dimension* D, an important parameter for quantifying fractal pattern`s visual complexity [43]. This parameter describes how the patterns occurring at different magnifications combine to build the resulting fractal shape [34]. For Euclidean shapes, dimension is described by familiar integer values – for a smooth line (containing no fractal structure) D has a value of 1, whilst for a completely filled area (again containing no fractal structure) its value is 2. However, the repeating patterns of a fractal line cause the line to begin to occupy space. The denser the coverage, the closer it gets to 2. But another characteristic of the particle is that it is composed of repeating patterns and it doesn't matter at what resolution you look at it. «*Pollock didn't know that he was painting particles, but researchers who examined his paintings found that over the years, the particle dimension in his paintings increased. Basically, brain researchers had people look at particle paintings and asked which particle scale appealed to them the most. It seems that we most enjoy or are most drawn to looking at paintings with a 1.4 particle scale (fractal dimension D). Beyond this level, it becomes too complicated for our brains. In his last paintings, Pollock painted on a 1.7 particle scale*» [42]. Our question is why 1.4 and not 1.2 or 1.6? There is no reply for the time being.
Has neuroscience been able to pinpoint the spot from which creativity derives?

«*In neuroscience there is a new field called neuroesthetics. It's a term that was coined by an English researcher, Semir Zeki. This field asks what is the biological basis, the neurological basis, of the need to create and enjoy art. Researchers look at, for example, which particle dimension appeals to us. Today it is also possible to scan the eye while it is looking at an work of art and to see what is observed. But to be honest, it's a little absurd, since in the end this doesn't really answer the question of why we enjoy art* » [42].

In my opinion, perception of the works of art and enjoying art is connected only to the brain of each person. There is no general quantitative criteria why "I like or do not like" this work of art. This is similar to the question *'what beauty or love is'*. Each person sees in his own way through the brain and the organs of senses. And this depends on his state, media, where he grew up, education, experience, age, mood, and even health. Neuroscientists study biochemical processes occurring in the brain but today this is like alchemy in the middle ages. As science and technology progress quickly I hope that the way for deciphering of biochemical processes occurring during enjoying (or not enjoying) art will be shorter than the way of alchemists to modern chemistry.

10. Epilogue, or Instead the End

An interesting and even paradoxical situation is formed in the world of art. People have misused the term 'abstract art' since the beginning of the 20th century and will continue to use the new connotation of 'abstract' forgetting its original meaning. People of art say that 'abstract art' is something immaterial and express an idea (an ‘abstract’) of personal perception. They forgot that ‘abstract’ is simultaneous elimination (simplification) and generalization. They made the first stage of elimination, did not generalize, and remain with this situation. Other people (non-artists, even scientists regarding 'abstract art') accepted this and use the term 'abstract' in the new simplified connotation.
I am not sure that it is possible to reach a consensus between people in society not to use the term 'abstract art' because it was changed and used in contrast to its original meaning (generalization). It is possible to reach consensus in science and technology, but in humanistic disciplines and art it is impossible. For instance, there are many scientific and technical international committees where scientific societies decide about the definition of each scientific and technological term. Each scientist and engineer uses terms only in one context, e.g., corrosion, acoustic emission, electric potential, etc. You will find exact definition of such terms. You cannot use some term in science and technology in a new interpretation. Nobody will understand you. It is forbidden by international scientific societies.

But … in art there is no single (unified, common, uniform) definition of the term ‘abstract’ and we will continue to use it in the new interpretation of individual perception as it has been used since the beginning of the 20th century.

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BAŞAK UÇAR

Paper: **Constant Redefinition of Relations in Responsive Environments: Unpredictability and Boredom as Generative Impulses**

Topic: Architecture

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Abstract:

This paper focuses on the new experiences in architecture provided by the introduction of new technologies and advances in the computational paradigm, which have given way to the design and building of dynamic and flexible environments called responsive environments. Being dynamic and flexible, responsive environments are able to respond to changing conditions in the environment and the user actions. Their capabilities, extending from capturing the information from the environment to providing real-time outputs illuminate interesting opportunities for designers and users.

This emerging experience of responsiveness defines new experiences for the user, where the notion of responsiveness goes beyond that of a computer responding automatically to a given input and denotes a continuous redefinition of the boundary between the users’ embodied self and its’ computed representation. In the constant redefinition of this boundary neither the responsive environment nor the user can be regarded as passive receptors. Instead, they act as dynamic and active entities evolving and redefining the mutual relationship in-between constantly. This paper focuses on this relationship, where the environment and the user can be intertwined in such a way that each one acts like an extension of the other and propose new experiences. In order to attain this continuous redefinition, the relationship between the user and the responsive environment should sustain its continuity and open up new experiences and relations.

In this paper it is argued that introducing generative impulses that can help to continue the interaction between the responsive environments can be considered as a generative approach that produces variation. Concepts of ‘unpredictability’ and ‘boredom’ are conceived as motivating and generative impulses that can help to continue the interaction between the responsive environment and the participant and generate new experiences and relations. The paper also exemplifies a design-research experiment that was implemented as a portable digital screen to test and discuss the conceptualization of ‘unpredictability’ and ‘boredom’ as generative impulses in responsive environments.

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Keywords:
responsiveness, responsive environments, boredom, unpredictability

Constant Redefinition of Relations in Responsive Environments: Unpredictability and Boredom as Generative Impulses

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Abstract

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1.Introduction

Architecture and the built environment have close relationships with several research fields such as technology, science, engineering and philosophy and are directly or indirectly affected by the developments in these fields. Advances in communication and information technologies, as well as recent developments in computer technology, material research and sensor networks influenced the definition of built environments and hence altered the architectural design practice. In the light of emerging progresses in these fields, built environment has been redefined to address dynamic, flexible and responsive qualities that bring forth new reflections on architecture. The idea of responsiveness is one of these reflections on architecture, which calls for the participation of the human and the machine in the definition of the responsiveness of the environment.

Parallel to the technological advances, the changes in social, economic, cultural, and technological contexts have also affected the experience of the environment. They resulted in intellectual transformations, and have altered the way participants experience the environment, which led to the conception of responsive environments as a design and research field in the recent decades. These environments enable to share and exchange information between different parties such as machines, participants and environment and introduce a new mode of communication and interaction. Experience of this updated interaction defines new experiences for the human and challenges the design of built environments.

2.Responsiveness and the Experience of Responsive Environments

The idea of responsiveness and being responsive to the changing circumstances has significant reflections on built environment and hence on architecture. The ability of the environment to alter its form and reflect the environmental conditions is related with the concept of responsive architecture and has gained significant importance in the last decades, especially with the application of computational tools and strategies in the design and construction of built environments. [1] Nicholas Negroponte provides the initial definition of responsive architecture and states that responsive architectures are ‘‘a class of architecture or building that demonstrates an ability to alter its form, to continually reflect the environmental conditions that surround it.” [1] Parallel to the definition of Negroponte, recent examples of responsive architectures make use of computer technologies to reflect the changing relations and conditions. Through the use of computers and computational theories, the proposed environment/system becomes sensitive to changes in the information and responds to the data received from the participant and the environment.

Definition of the responsiveness through computer technologies gives the environment the ability to trace and respond to the changing conditions or stimuli from different sources: the participants, environment, and system. Computer technologies are made use of to include the computational behavior at any phase of the interaction process such as gathering information from the environment, processing the gathered information or providing a response to the environment.

Through the use of sensors, actuators, processors and various control theories, the environment gains the ability to simultaneously scan, process and provide the already defined counteraction of the data that is present at the environment or sent to it. [2] This advanced communication between the participant and the environment defines new spatial experiences and provides the desired compatible, effective and dynamic performance of the environment. The advanced communication enabled through the use of machines equipped with real-time processing technologies allows the environment to attain the desired adaptability and harmonious interaction between different parties, which is called the responsiveness of the environment. The responsive systems also enable the interaction between the participant and the environment and define the response of the environment to the changing conditions, social interactions and behavior of the participants.

The interaction between the participant and the system has evolved into a reciprocal relationship in the emerging examples of responsive environments, where each party involved in the interaction process respond to each other and redefine themselves. In their reciprocal relationship both the human participant and the system are considered as active and dynamic entities rather than passive receptors. They participate in the interaction process, affect the other parties and are affected from them. Through the spatial and technical systems employed in the system, the responsive environment acts like a translator and provocateur of certain experiences of feelings, emotions, behaviors, or states. In this manner, the experience and response of the participant and is detected and delivered both to the environment and to the other parties involved in the interaction process.

Engagement of the parties in the interaction process alters and redefines the relationships in-between and affects the definition of the environment. In this redefined environment, the participant can be considered as proactive parties as they are affected from the others and also from the environment. Extended into the responsive environment, these proactive parties enable the definition of more dynamic environments, which trigger the interactions between the machines, participants, their environment and wider networks of relations affecting them.

3.Extension of Relations into the Environment

The search for responsive environments that search for the extension of the parties on each other can be traced back to 1950s and 1960s, where Cedric Price and Gordon Pask provided the initial examples. However, in the last decades there is a remarkable increase in the number of studies that aim to attain the responsiveness through the use of technological advances such as ubiquitous computing, sensor systems, smart materials and textiles. These tools and strategies contribute to the definition and experience of the changes in the environment through the use of different interfaces, operating systems, and sensor-network technologies and enable the extension of the participants into the environment in different ways. [3]

Equipped with these systems and network technologies, these environments enable the interplay between the parties of interaction. Since the participants are interlaced with the responsive interfaces and do not conceive the location and the working principles of the responsive interface at first sight, the proposed experience becomes unpredictable for the participants.

In the recent examples of responsive environments, the participants do not only interface but rather interlace with technology as they interact with the responsive systems and network technologies embedded into the environment. [4] As the participants and the technology are weaved together, the relationships between the participants, physical and social environment and the responsive system can be projected and extended into the environment. The interaction between them provokes the network of relations, defines new experiences for the participant and promises new concepts of built environment.

In this interplay, the participant can also be equipped with these systems and network technologies, which are integrated into the environment or located on the human body. Wearable technologies such as of head-mounted displays, digital technology, auditory displays, and body tracking technologies or smart textiles add computational and communicational capabilities to the parties of interaction and enable their active participation. [5] In the interaction process making use of wearable technologies, the coupling of the technology, human and the environment is defined through the responsiveness of the environment. Their coupling allows the participant and also the responsive environment to affect and be affected from the information provided through the interaction process. The connectivity between the parties and the responsiveness of the environment leads to a composite experience, where each party is affected by the experience of the other. Therefore, it can be claimed that, conception of the human participant as being interlaced with the environment through computational devices introduces new experiences for the participant and influences the formation and definition of the built environment.

In this reciprocal relation, both the human participant and the environment are defined as being in continuous transformation as the relations redefined during the interaction affect them. The relations defined between the parties are extended into the environment and the mentioned technologies are refolding the embodiment of relations and sending back into the interaction process. [6] The refolded relations redefine and/or transform the participants and initiate new data input to the interaction process. In order to attain the continuum of this process, in the recent examples of responsive environments, it is focused on multiplicities of participants and relations rather than single and static entities, where each party is coupled with the other through the relations. The experiences of the participants alter simultaneously as new relations are defined between the environment, the participants and the responsive interface. This calls for the active involvement of the participants and the interface in the definition of responsive environment, which enables the continuum of the interaction.

4.Boredom and Unpredictability as Generative Impulses

In order to experience the aforementioned transformations, the data exchange between the participant and the environment as well as the type and process of interaction has to be defined in a competent and effective manner. This harmonious relation can be possible through the continuous transformation of the interaction between the participant and the environment and the data. Besides providing continuous data flow and responding to the interactions according to the relations embedded in the system, the responsive environment provides new expansions and experiences. However, when the responsive system responds to the similar data inputs with similar outputs during the interaction process, it acts as a passive element instead of a provoking one. In such a case, the continuous interaction between the environment and the participants may blur and lead to predictable and similar experiences, which do not inherit variation of experience and relations. Therefore, it is possible to claim that predictability and similarity of the interaction between the environment and the participants may define a monotonous relation for both parties and disrupt the continuity of the interaction.

The contribution of the unpredictability of the interaction to the responsiveness of the environment is the possibility of defining the variability of experiences and relations. It is the unpredictability of the variations in the interaction process, not the situation of the interaction and the environment that is out of control. In the design and definition of responsive environments, the concept of unpredictability can be conceived as a motivating aspect and a generative impulse for the variability of experiences defined by the responsive environment.

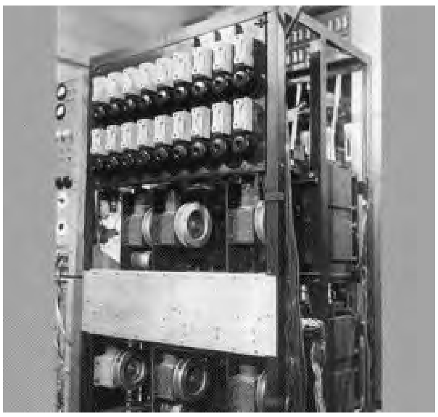
Since responsive environment is sensitive to the data received from the participant and the environment and reorganizes itself accordingly, the participant is provided with momentum, change and flow of action. Although, this circumstance seems to lack the experience of boredom at first sight, when highly intuitive systems were proposed or the interactive experience is repeated constantly, the participant may take a passive role. This passive condition may lead to boredom and loss of stimuli from the participant, which may result in the diminished or even totally disappeared continuity of interaction. However, boredom factor can be taken into account as a generative impulse for the responsive environment, which may trigger the relations and provoke the participants and the responsive system to actively participate in the interaction process.

The concept of boredom is commonly correlated with monotonous or repetitive activities [7] and with the dominance of unpleasantness, constraint, and repetitiveness. [8] Emphasizing its negative aspects, most of these definitions and descriptions underline that it is an individual experience and perception either of a situation or time interval. Susan M. Shaw defines boredom as ‘a state of under-stimulation, under-arousal, lack of momentum, or a lack of psychological involvement associated with dissatisfaction in the task situation’. [9] Psychoanalyst Ralph Greenson emphasizes the dependence of boredom on the experience of time and relates this feeling to the existence of a sense of emptiness, a passive attitude and a distorted sense of time in which time seems to stand still. [10] In fact, the correlation of time and boredom is a common approach in the studies about defining and describing boredom.

Another approach that emphasizes the relation between boredom and time is claimed by Heidegger. Heidegger defines boredom as a special fundamental mood related to the relationship between being and time. [11] Considering the relation between time and boredom, Heidegger differentiates between the experiences of boredom considering the individuals' elapsing the time, and provides three different levels of boredom; *becoming bored by*…, *being bored with*... and *profound boredom*. [11] These three different levels of boredom the time is not identified as the actual length of the time, but instead the individuals' experience of that specific time.

All these definitions underline the characteristics of a primarily negative state, which can be considered as an important factor affecting various aspects of a person's life. However, even though boredom is certainly associated with several negative effects, it can also provide positive motivation for experiencing new possibilities. Since boredom is considered as an indication of insufficient concentration or failure, boredom can provide signal for revising the situation, performance or concentration and have an adaptive role on the individual. [12] Therefore, boredom condition can be welcomed at certain circumstances as it inherits a potential of positive reinforcement and impetus. In responsive environments, the relation between the boredom proneness level and the continuity of the experience can also be approached with a similar attitude and the boredom factor can be considered as a generative impulse that triggers the relations defined between the parties of interaction and the responsive environment.

An early example of responsive environment that conceptualizes the experience of boredom as a provoking input is the MusiColor machine designed by Gordon Pask. Constructed in 1953, MusiColour machine was designed as a performance system reacting to the auditory input from the human performer in a concert. [13]



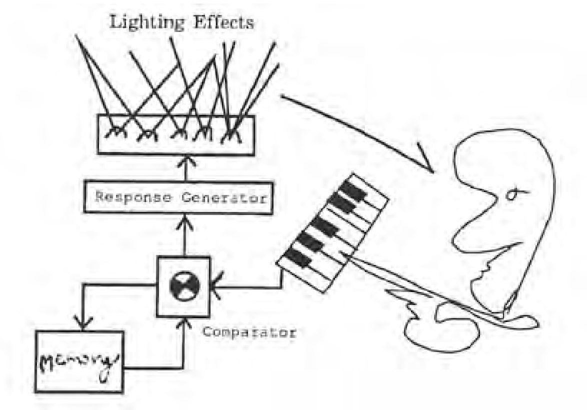


Figure 1 (Left): The control system of MusiColor Machine. [13]
Figure 2 (Right): Diagram of MusiColour machine. [14]

The machine that actively participated in the performance sensed the sound produced by the performers (musicians) and regarded them as inputs from the environment. [15] Processing these inputs, the machine responds to the environment and the performers with lights in different colors flashed with different rhythms. [15] However, if the machine recognizes that it responds (flashes lights) in the same manner for a specific period of time, it gets bored and changes the flashing-pattern. In doing so, it alters the mode it determined for reacting the input (sound) driven into the environment and machine by the performers. [15] It is assumed that, these alterations in the flashing pattern will stimulate the performers with strange and unexpected experiences, which may encourage them to change the way they performed. [16]

In addition, if the rhythm and the inputs gathered from the environment are too continuous, or the frequency range is too consistent, the machine again gets bored and searches for other frequency ranges. It only responds to the performance when it traces those desired frequency ranges or a change in the inputs provided by the performer. [13] Therefore, through responding to a certain frequency range until it gets bored and searching for other possibilities for different interactions or rearranging and changing its flashing-patterns for increasing the stimulation, the MusiColour is regarded as an on-stage participant for the performance. [13]
In relation to the research on responsive environments and the concept of boredom, a test platform is proposed, which enables to discuss the interaction process between the participant and the responsive system. The proposed structure is a surface that is composed of several panels having groups of LEDs. These LEDs are activated through the interaction of the participant with the surface, which provides data for the system through the sensors embedded in the surface. The sensors are sensitive to the existence of an object, which provides visual and aural outputs. Each sensor controls a group of LEDs, which are affected by the movement of the object in relation to the proposed surface structure. The processed data gathered through the sensors creates different lighting patterns and aural responses.

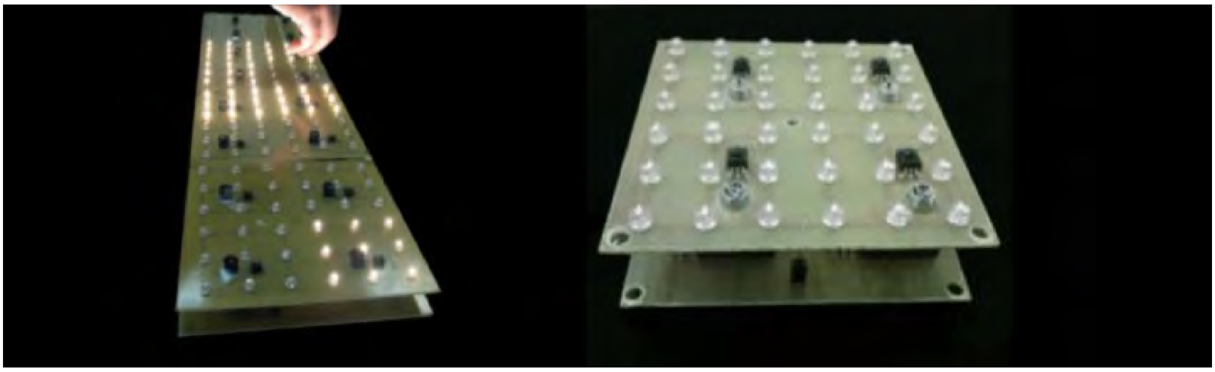


Image 3: The modular panels used for the responsive surface structure.

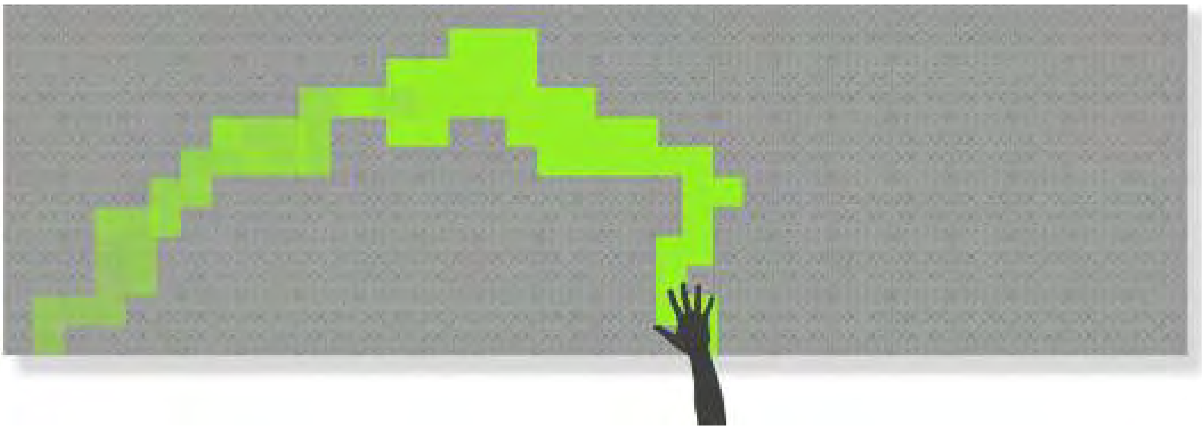


Image 4: Abstract representation of the interaction scenario of the responsive surface.

The proposed surface was tested through a group of participants and the interaction processes were recorded and analyzed. Besides, a questionnaire was applied to the participants, which guided the documentation of participants' experiences and comments. Analyzes of the interaction process enabled to reveal the activation frequency of each unit by the participant. After analyzing and documenting the experience of each participant, the data gathered were juxtaposed and several graphical representations were provided (Image 6).

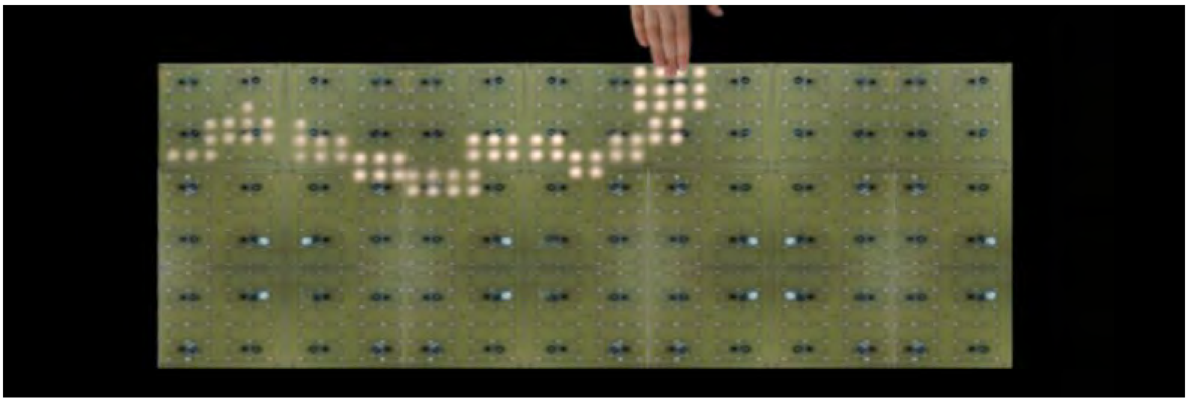


Image 5: Snapshot from the interaction process between the participant and the responsive surface.

Referring to these analyses displaying the activation frequency of the units, it was concluded that, some units were activated frequently, while some were never activated. Moreover, the analyses revealed that the units located at the middle of the model were the mostly activated ones. On the other hand, the passive condition of the units located at the upper left and right corners (A and B axes) was considered as a significant indication.

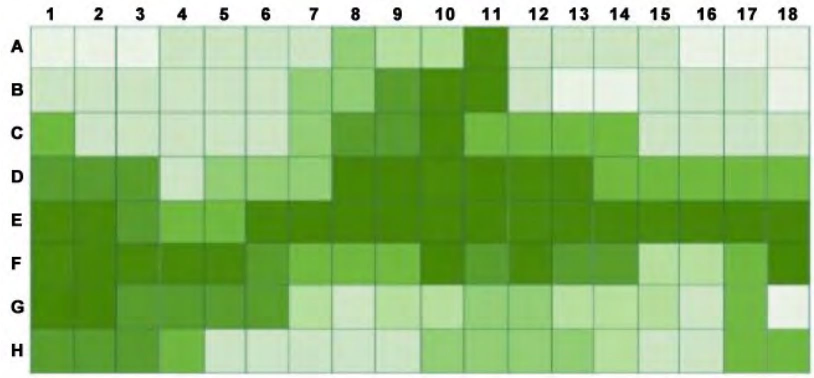


Image 6: Graphical representation of the activation frequency of the units in first model application.

Considering the results and evaluations of the first application, diversifying the interaction inputs/outputs between the participant and the surface was proposed as a way of satisfying the continuity of the interaction. Besides, unpredicted interaction scenarios was considered to be another factor that may trigger the relations between the parties of interaction. Therefore, a second model was provided and both visual (light) and aural (buzzer) outputs were included in the interaction process. In the second model, the activation frequency of the units was challenged by the inputs provided by the system to the environment and the participants. According to the activation scenario provided, if the participants activate the same group of elements more than 5 times in 10 seconds those units fall asleep and are inactivated for 5 seconds. Even if the participants try to activate those units they do not respond to the inputs provided by the participants. Moreover, if the participants activate the same units for more than 5 seconds without any interruption, the system gets bored and provides an aural response of buzzer sound. After the tests performed with the same participant group, the screen captures and questionnaire forms were analyzed with a similar approach that is used in the analyses of the first model application.

Referring to the graphical representations about the activation frequency of the units (Image 7), it was concluded that second pre-model application provided a more homogenous distribution. It was noticed that the frequency of activation that was concentrated at the middle part and central axes of the first model was diffused in the second model application and concentrated mostly around the units that provide an aural output. In addition to this, the analyses revealed that when the participants realized that the sensors are sensitive to a certain distance, they searched for other ways of interaction and used different parts of their bodies (their arms and faces) to activate the system.

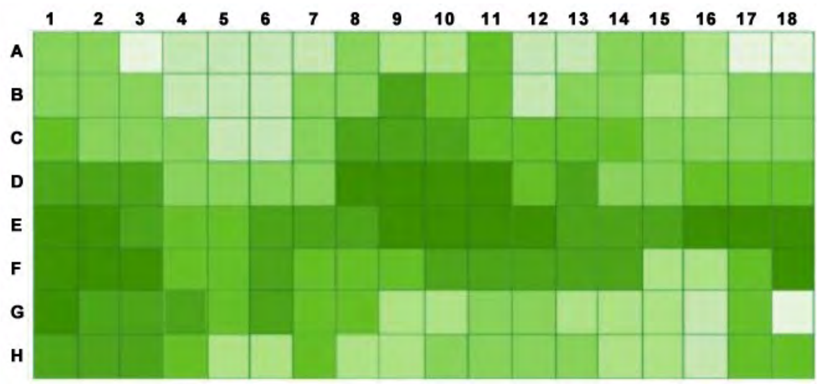


Image 7: Graphical representation of the activation requency of the units at second model application.

In the questionnaires the participants indicated that the aural response (buzzer) of the system had challenged their interaction with the system and they defined this condition as “unexpected”. Analyzes of the interaction processes reveled that the unpredicted experience of the aural response of the system guided the participants to search for new ways of interacting with the surface. Therefore, introduction of generative impulses that is unpredicted by the participant can also be considered as a way to provide the continuity of the interaction.

5.Conclusion

In reference to these analyzes it may be claimed that in the synergetic correlation of the responsive system with the participant and the environment, the interaction between the parties may lose its continuity. Interruption of the continuity may lead to similar experiences and obstruct the participation of the human and/or the system in the definition of the responsiveness of the environment. Unpredicted input to the environment inherits the potential of transforming the interaction between the participant and the system/environment that has already lost its continuity. The unpredictability of the experience may generate diverse interaction scenarios and new experiences. Besides, in the design and experience of responsive environments boredom can also be considered as positive stimuli for attaining the variety in experience and continuity of interaction. The experience of boredom may act as a drive for change, where both the responsive interface and the participant affected each other to satisfy the continuity of the interaction. Therefore, the search for the continuity of interaction can be considered as a generative approach that potentially defines dynamic and complex relations and able to generate variation in the interaction process, definition and experience of the built environment.

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Boris Magrini

Paper: **Should generative art be political?**

Topic: Visual Art

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Abstract:

The history of generative art began long ago. Over time, it has come to encompass a great variety of techniques and products. Despite this diversity, today generative art is strongly associated with a very restricted category of works, mainly abstract images produced using computer software and evolutionary algorithms. On the one hand, application of generative art to computer graphics, the movie and gaming industries, electronic music and architecture has helped to develop the form both conceptually and commercially; on the other hand, within the world of contemporary art – and, more specifically, new media art – generative art seems to be largely ignored or misunderstood as an artistic production. Its specificity, as demonstrated through its recent evolution, is partly to blame for its exclusion from important venues on the contemporary art circuit, such as the numerous biennale and other exhibitions in major museums. Moreover, some art historians have pointed out that generative art is largely "retinal" or even conventional from an aesthetic point of view, and thus lacking in narrative and ideas. Because of its nature, generative art appears unable to address relevant societal issues, which may be why it has failed to seduce art critics and historians, not to mention the broader public.
In my contribution to the 2012 edition of the Generative Art Conferences, I would like to emphasize the variety of generative art throughout its history and in particular works that have tackled topics relating to contemporary politics and society. Although these works are usually considered outside the scope of generative art – a scope which the Generative Art Conferences have substantially contributed to establish and discuss since its first occurrence in 1998 - they do satisfy the common and accepted definitions of the genre. In addition, their topical breadth serves to exemplify the presence and success of generative art in the more traditional contemporary art world. I would also like to raise a few questions regarding the future and evolution of generative art. Must generative art become political to be accepted by the public and the traditional contemporary art field? If so, will this art be fundamentally altered, and will it lose its appeal for its original audience? What are the opportunities and challenges confronting generative art in the future? Historical works such as *MEART* by the SymbioticA Research Group and *Wrong Browser* by Jodi, along with more recent works, will provide examples for discussion of these questions.

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Keywords:
Generative art, hacktivism, net art, tactical art, biopolitics.

Should generative art be political?

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Abstract

The history of generative art began long ago. Over time, it has come to encompass a great variety of techniques and products. Despite this diversity, today generative art is strongly associated with a very restricted category of works, mainly abstract images produced using computer software and evolutionary algorithms. On the one hand, application of generative art to computer graphics, the movie and gaming industries, electronic music and architecture has helped to develop the form both conceptually and commercially; on the other hand, within the world of contemporary art – and, more specifically, new media art – generative art seems to be largely ignored or misunderstood as an artistic production. Its specificity, as demonstrated through its recent evolution, is partly to blame for its exclusion from important venues on the contemporary art circuit, such as the numerous biennale and other exhibitions in major museums. Moreover, some art historians have pointed out that generative art is largely "retinal" or even conventional from an aesthetic point of view, and thus lacking in narrative and ideas. Because of its nature, generative art appears unable to address relevant societal issues, which may be why it has failed to seduce art critics and historians, not to mention the broader public.

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Some considerations regarding generative art and its definition

The production and reception of generative art, that is to say, art created using procedural and autonomous systems, have changed over the years. Generative art has been successfully implemented in the film and gaming industries, for example, and is currently increasingly being employed in architecture and design. With respect to the fine arts, some works of generative art have occasionally appeared in exhibitions, festivals and museums mostly dedicated to new media art. Examples include Ars Electronica in Linz, Transmediale in Berlin, VIDA in Madrid, the International Symposium on Electronic Art and, of course, the Generative Art Conferences, the first and still one of the few international events dedicated exclusively to generative art. Artists such as Karl Sims, Scott Draves and William Latham are frequently cited in publications that cover generative art and are credited with having gained international recognition for the genre. Even in the domain of fine arts, generative art is commonly associated with works produced through the use of computing devices and evolutionary algorithms, with abstract results, whether in printed form or video screening.

However, the commonly accepted definition of generative art leaves room for a greater variety of approaches, of procedural systems and, in the end, of works produced. As already asserted by Celestino Soddu, who in collaboration with Enrica Colabella and their students of the Generative Design Lab at Milan Polytechnic University organised the first Generative Art Conferences in 1998: “The Generative Art is a way to think and to design. Following this approach we can find, united by the same enthusiasm, architects and mathematicians, poets and musicians, physicists and semiothics, philosophers and painters, engineers and designers”[1]. The multiplicity of approaches and applications that Soddu points out are reflected in the variety of international works—ranging from visual art to architecture, from design to music—that have throughout the years contributed to the conferences. In describing his research in architecture and urban design, which he had already started in the eighties, Soddu explains the possibilities in adopting procedural methods and generative algorithms to create unpredictable results beyond the restrictions of traditional and artistic production. Soddu offers us the following definition: “Generative Art is the idea realized as genetic code of artificial events, as construction of dynamic complex systems able to generate endless variations”[2]. On the other hand, he also explains that generative art should not be seen only as a tool, but rather: “It is a philosophy with a strong and humanistic imprinting: each generative project can be implemented only starting from a hypothesis, like all scientific discovery paths, from a subjective vision of possible worlds, of possible rules, of possible increasing complexity”[3]. This visionary conception, which complements his technical definition of generative art, is supported by the argument proposed by Enrica Colabella, who considers that: “We can define Generative approach as a run from idea to shapes, from shadows to light”[4].

Since the first occurrence of the Generative Art Conferences, many artists and researchers have proposed their visions and definition of this particular artistic practice. A recurring definitions among those widely discussed in the context of generative art is that proposed by Philip Galanter: “Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art”[5]. The reality of artistic production is, of course, much more complex then a definition: Indeed, the current trends and representation of generative art in the field of new media art can be attributed to a variety of factors that are difficult to examine objectively. Nevertheless, the definitions proposed during the Generative Art Conferences by Soddu or by Galanter are today a standard and are frequently cited by artists and historians. What is worth calling attention to in these definitions is that they credit generative art with encompassing a far greater range of artistic practices and works than has typically been recognized over the last decade. For example, poems and texts created using the cut-up technique from Tristan Tzara or from William Burroughs, some of John Cage's musical compositions, installations by Hans Haacke and works of artificial life by Christa Sommerer and Laurent Mignonneau all satisfy these commonly accepted definitions of generative art.

Many other attempts to define generative art have been made, and it is not my intention today to present all of them. I would like to add, however, one definition that I find interesting and that will allow me to introduce the examples of artworks that I wish to discuss. In his guide to generative art, artist Matt Pearson expresses his dissatisfaction with Galanter's definition, although he does not reject it, because, "although this is accurate and descriptive—and a long sentence with all the right words—a single phrase like this isn't enough. I don't think it quite captures the essence of generative art (GenArt), which is much more nebulous. In my mind, GenArt is just another byproduct of the eternal titanic battle between the forces of chaos and order trying to work out their natural harmony, as expressed in a ballet of light and pixels"[6]. Pearson seems willing to try a less technical definition and sufficiently interested in grasping the hidden forces behind generative art to venture a few more aesthetic and philosophical considerations. The definition that he offers is quite audacious, indeed: "Generative art is neither programming nor art, in their conventional sense. It's both and neither of these things. Programming is an interface between man and machine; it's a clean, logical discipline, with clearly defined aims. Art is an emotional subject, highly subjective and defying definition. Generative art is the meeting place between the two; it's the discipline of taking strict, cold, logical processes and subverting them into creating illogical, unpredictable, and expressive results"[7]. What is extremely interesting in this definition is that, for the author, the artistic and poetic qualities of a work of generative art reside in the act of subversion of the mechanical and rational properties of the system used. In this case, Pearson certainly has the computer in mind, and thus is principally addressing works that are commonly and currently associated with generative art. We could ask, however, in what sense and how these works display the act of subversion that Pearson seems to value so much in his appreciation of generative art. Is it the case that generative art is flirting with more subversive strategies? Before proposing a few answers, I will briefly present some problems that generative art has faced in recent times, especially in its critical reception within the new media art world. Subsequently, I will present examples that might offer some interesting food for thought concerning the debate about generative art. I will also compare these works with the previously discussed definitions.

The critical reception

Although artists and researchers working in generative art usually find common ground for discussing their visions, work and ideas, the genre is not always accepted, understood or appreciated by the artists, curators and historians within the larger field of contemporary art. In fact, generative art – and new media art in general, to which generative art belongs – is mostly ignored by contemporary art world professionals. International events such as the Venice Biennale or Documenta, in Kassel, Germany, basically neglect the most remarkable artists working with digital media and new technologies or, at best, shunt them off to the side. In fact, new media art is relegated to a very specialized group of festivals, museums and publications, such as Ars Electronica, Transmediale, ISEA and the journal *Leonardo*. It is in this subfield of contemporary art – which only rarely offers access to the most traditional world of gallery and museums dedicated to contemporary art in general – that generative art found space to present itself and to evolve. Some of the most important generative artists have been recognized, shown and awarded during these events. What exactly is the position of generative art within new media art? How is it appreciated and described by the professionals who work in this field?

Invited to discuss generative art at the Generator.x Festival in Oslo in 2005, Susanne Jaschko, who co-directed the Transmediale Festival between 2001 and 2004, characterized generative art as being retinal. She also made clear that her appreciation of generative art concerned a very restricted collection of works that are commonly associated with the genre. "Is generative art retinal? I would summarise my observations on the aesthetics of generative art by answering: yes, it is strongly retinal in its best sense, but not solely. (...) Unfortunately, the emphasis on sensory perception continues to keep it out of the core of the media art discourse"[8]. Although Jaschko acknowledges that generative art is retinal in an aesthetically appealing way, she also suggests that it lacks the conceptual and contextual qualities needed to contribute in a substantial way to the core debates developing within the new media art scene. Undoubtedly, the interest of generative art is not limited to output, product or aesthetic qualities. Another important aspect is the system itself, created by the artist, which consists mostly of codes in a variety of programming languages. This, too, is acknowledged by Jaschko, although, as she correctly points out, in most cases, the underlying code and its conceptual qualities are hard for the public to appreciate. In their influential book covering the most recent trends in new media art, Joline Blais and Jon Ippolit dedicate a few pages to generative art. In a chapter on artificial life, they present the work of Philip Galanter, William Latham and Joseph Nechvatal, about which they are somewhat sceptical. They conclude that "what is more striking than the stylistic differences, however, are their similarities – a fact that calls into question Latham's claim that artificial life can extend art 'beyond the human imagination'. (...) these end-products of artificial life look surprisingly conventional from an aesthetic point of view, given how revolutionary their process are from a scientific one"[9]. Here, again, the critique of generative art mostly considers the aesthetic qualities of the visual product rather then the entire process.

These critiques should nonetheless be taken seriously because they come from specialists working in the new media art field. It is therefore important to now briefly consider the term new media art. Innumerable articles have been written questioning and debating the relevance and pertinence of the term. Although new media art may have been a useful and practical term during the first decades of the emergence of this specific form of artistic production, critics later found it increasingly dubious, in particular because of the uncertain meaning of the term "new" itself. Indeed, considering how many devices and software have become obsolete, and how quickly, it is somewhat amusing to think that a very recent trend in the new media art scene is the development of theories regarding media archaeology. Hence, the rush of curators and historians to urge that the word "new" be left out of "new media art" also signals their wish to emphasize the significance of media and art in the description of their field of curatorial and critical practice. For sure, media art is an artistic production that relies on and uses communication technologies. Consequently, it is only natural that it is appreciated by the community as an art that may deal with questions related to communication technologies and how they are

implemented in society. The inclination of media art to comment on society and technology is something that has been stressed by many cultural theorists, some of whom even consider it to be the defining characteristic of the field. Christiane Paul, for example, affirms that “new media art often critically investigates its underlying technologies and their encoded cultural and commercial agenda, automatically, as a result shifting focus to the medium itself”[10]. In the same vein, Anke Hoffmann and Yvonne Volkart affirm that “we interpret media art as the art form investigating the world and subjectivity with the means of technical progress and its dispersive affects”[11]. In Italy, commenting on a selection of prominent works that exploit and adopt new technologies, Mario Costa in turn affirms that these works invite spectators to enter the field of communication technology but then teach them how to subvert the practical function of these technologies. In this sense, says Costa, the artists are assuming an ethical function: “Essi insomma delineano una fenomenologia del 'blocco comunicante' e ne seguono la logica, ma la fanno lavorare a vuoto ottenendo così un doppio risultato: da un lato sottraggono 'il blocco' alla dimensione della prassi e, per ciò stesso, lo introducono in quella dell'estetico; dall'altro lato sollecitandoci ad entrare in vario modo nel 'blocco' stesso, ci indicano e ci addestrano ad una performatività legata al tecnologico, ben diversa da quella che ci viene quotidianamente richiesta, svolgendo così una funzione che non esitiamo a definire etica”[12].
If we accept the considerations put forward by the critics, historians and curators working in the field of new media art, we must recognize that it is not the fascination of the new or experimenting with technologies that defines or, at the very least, explains the interest of this specific artistic form. Shifting the focus to the medium itself, subverting technologies, commenting on the world and society – this, in fact, is what is expected from artists who develop and use new technologies, especially media technologies, in their work. Of course, these are just a few examples, but they nonetheless serve as a gauge of the current trend. If this is the current critical approach to media art, one might think that little space is left to artists who work with technologies instead of working against them. As an artistic production that is culturally situated within new media art, generative art traditionally represents dialogue and symbiosis between art and technology. It is thus not surprising that many leading researchers in the field have produced innovative artworks or that many artists who started experimenting with generative art have developed some extremely interesting projects and publications for scientific research. Could it be that what appears to be the very driving force of generative art – an art form that has evolved out of a fascination for technology, rather then a critical position – is what keeps it from being successful in the exclusive field of new media and contemporary art? To put the question another way, does generative art need to be political to be accepted and presented by critics and curators currently working in new media art? What possibilities exist for artists engaging in generative processes? Before attempting to answer these questions, I would like to present and discuss a selection of artworks that are generative and yet address political, economic and social issues.

A selection of prominent but atypical works

The project originally called *Fish and Chips* and later renamed *MEART – The Semi Living Artist* is exemplary of a collaborative work. Many actors were engaged in this project, which was developed by the SymbioticA Research Group at the SymbioticA laboratory of the University of Western Australia in collaboration with the Georgia Institute of Technology in Atlanta. Among the actors, Oron Catts, Ionat Zurr and Guy Ben Ary, who previously founded the Tissue Culture & Art project, played a significant role in its early development. As defined on the website dedicated to this work: "*MEART – The Semi Living Artist* is a geographically detached, bio-cybernetic research and development project exploring aspects of creativity and artistry in the age of new biological technologies"[13]. The work was a complex installation, distributed in two far-distant locations. Cultured nerve cells in the neuroengineering lab of the Georgia institute of Technology served as the "brain" of the work, while a robotic arm at the SemioticA laboratory constituted the body communicating with the brain through the Internet. In the room where the robotic arm was at work, a camera recorded images of spectators and compared them to the ongoing drawing produced by the robotic arm. The recorded image was then transmitted to the brain and transformed into a stimulation frequency that fed a neuron culture dish which was composed of neurons distributed on a multi-electrode array. The neurons spontaneously grew and interacted to form a biological neural network. Finally, a computer program analyzed the signals from 60 areas of the neuron dish and sent a message back to the robot arm to instruct it to move and produce an image. The brain and body thus communicated in a loop, mutually influencing each other. Alternatively, music was produced instead or together with the drawing. The focus of this work, which combines elements of biotechnologies with computing machines, was explicitly on creativity. The purpose of the artists was "to create an entity that will evolve, learn and become conditioned to express its growth experiences through art activity"[14]. In fact, this was a work of generative art with all the traditional generative ingredients, although the biotechnology involved was probably innovative at that time. A system was set in motion to create a result, a drawing or music, which could not be predicted by the creators of the system. Moreover, the system had the possibility to evolve and adapt in response to the environment. It is not surprising that the focus of the artists was on creativity, which is considered as a distinctive human feature and thus is quite often explored by artists and researchers engaging in artificial intelligence, artificial life and robotics. Yet, the artists involved in this project seemed to have other objectives besides investigating new possibilities for producing autonomous and artificial creativity. In the text of the catalogue presenting the work for the first time at Ars Electronica in 2001, the artists state that "biology is evolving from a phase of discovery into a phase of creativity and utilization. The effects on society will be profound. Hands on wet biological art is starting to be seen as valid means of expressing cultural and artistic perceptions as well as exploring neglected areas in biological research. It explores the nature of contestable futures that may arise"[15]. In another publication, they went further, affirming that "this approach can be, and has been, utilized by artists who are working with biology; for the non-scientist, the 'wet' experience in the laboratory involving some degree of life manipulation can be seen not only as an ethical conduct but also as a political act. A political act that goes beyond the democratization of the technology, to the act of breaking down dominant discourses, dogmas, and metaphores to reveal new understandings of life and power structures it operates within"[16]. In my opinion, *MEART* is a significant work in the history of generative art particularly because of its twofold qualities: On the one hand, it is a complex and collaborative work that exploits technologies in pursuit of the goal of creating emerging behaviours; on the other hand, it states explicitly, at least in the articles that publicly presented the project, the aim to question, on an ethical and political level, the very technologies used in the work.

The second work I would like to discuss is *Wrong Browser* by artist duo Jodi (Joan Heemskerk and Dirk Paesmans). It consists of a series of browsers that have been made available as software on CD-ROMs or as a free download from the artists' website. Because the work functions as a browser, it connects to the Internet and displays the results of searches on the screen of the user. It is an interactive work intended to be experienced on one's own computer. Yet, as the title suggests, the browser doesn't function as a conventional one, and the experience is quite frustrating for the spectator. The program loads automatically random elements from the web, displaying both text and source code. And although the user has the possibility to enter his or her own IP address on the browser, the program has been conceived to prevent users from employing it in a practical and useful way. Moreover, the experience is complicated by the graphical appearance of the browser, which generally mixes and overlaps the search windows to further complicate navigation. The artists have described the work as being a very simple program, consisting of ten lines of code. *Wrong Browser* is not a work of generative art in the traditional sense. It doesn't look like one, it has not been produced as one, and the artists would probably not even call it a work of generative art, although they have stated quite clearly that they did not intend to be net artists either. *Wrong Browser* is the opposite of *MEART*: It is a very simple work, created by two artists who are not deeply involved in working with new technologies. Moreover, from a thematic point of view, *Wrong Browser* has very little to do with generative art, as it doesn't try to produce emergent behaviour in the historical sense associated with research in artificial intelligence. Nevertheless, *Wrong Browser* is a work of generative art according to the commonly accepted definition of it: The artists have written code meant to be run on a system that will generate unpredictable graphical output. It is not surprising that this trait has been pointed out by other historians. Florian Cramer, for example, affirms that "alluding costantly to the popular cultural semiotics of software interfaces, jodi manage to make software art - and thus also generative art - even where they don't employ algorithmic programming, a conceit that challenges the whole conceptual grounds of both art genres"[17]. The output is unpredictable because the system exploits the information on the Internet to generate the output, and furthermore because there is a degree of interactivity. Of course, one might argue that any software or process that allows interactivity and unpredictable results could be considered generative, for example a real browser. One should not forget, however, that *Wrong Browser* is an artwork and has been conceived as such. Furthermore, the graphical output plays an essential role in the significance of the work; that is to say, the artists desire that users experience the work not only on a conceptual level but also on an aesthetic one, and more particularly that they question their expectations concerning the graphical qualities of a common tool like a browser. This, in fact, is where *Wrong Browser* reveals a political impulse. In an interview with Tilman Baumgaertel, the artists affirm: "From the very beginning on, it has been the most important task for JODI to do everything wrong on the internet that can be done wrong. That's the core of all our work"[18]. In a previous interview, they claimed that: "Wir machen diese Sachen, weil wir wütend sind. (...) Es ist offensichtlich, dass sich unsere Arbeit gegen High Tech richtet. Und wir kämpfen auch auf graphischer Ebene gegen den Computer"[19]. It is clear that Jodi's work doesn't stem from fascination with the technologies and products that they exploit and hack such as computers, browsers and video games. Rather, the work evolves

from a critical approach to these technologies. By creating interactive, generative works to be individually experienced on personal computers and laptops, the artists invite users to question their attitude to and dependence on these technologies as well as the corporations that produce and control them.
The works I have already mentioned are very well known historical examples. What I wish most to emphasize is that they promote different perspectives on generative art, in particular by abandoning the tradition of purely abstract and conceptual production to embrace other, more critical areas of discourse. Those are not isolated examples; other recent works have a similar character, offering a variety of approaches, methods and results. For instance, *OneTree(s)* by Natalie Jeremijenko, *Translator II: Grower* by Sabrina Raaf or *Fifty Sisters* by Jon McCormack all employ generative processes to tackle ecological, cultural and political issues.

What future for generative art?

These examples enable interesting perspectives for generative art as a production rooted in the new media art field. They also illustrate Matt Pearson's plea for generative art to satisfy a more subversive drive. They also affirm that, as an artistic practice, generative art possesses the tools to address issues relevant to contemporary society beyond its conceptual and aesthetic tradition. In so doing, generative art has the opportunity to build a stronger presence in the new media art scene where those topics are frequently debated. However, should generative art in fact become more political to be accepted and presented by the critics and curators currently working in new media art? It is no mystery that the world of contemporary art functions according to rules that, though complex, are not much different from those regulating other areas of production. Since demand for political art in new media art seems to be growing, it is natural for artists to respond by producing work that satisfies this demand. On the other hand, work that is created only through an opportunist desire to succeed might not be as emotionally moving or innovative as work driven by passion. Joline Blais and Jon Ippolit pose the following question: "If programming is an art, is any programmer with high standards an artist? No. As we shall see, software artists deliberately misuse code. Like the immune system's polymorphous antibody production, this perverse practice lends code art a quirky and prophetic vision that is unlikely to emerge from a purely utilitarian approach"[20]. If a purely utilitarian approach will not make generative art interesting from a creative point of view, then neither will a political approach, although it might, in the short run, make it more accessible to a larger group of curators. It is not my intention to propose a list of do's and don'ts for artists. Nevertheless, we are seeing some signs calling for art that can address relevant social issues. Generative art is capable both of producing astonishing graphical images and developing commercial applications, for example in the digital film and gaming industries. It can also produce conceptual works that challenge our understanding of creativity, intelligence and natural evolution. Nevertheless, it is obvious that generative art can also be used, or even abused, to address social, political and ecological issues. This is something that, more then anything, should at long last be acknowledged by critics and curators who deal with new media art and who, because of lack of information, curiosity or perseverance, have been unable or unwilling to follow the evolution of specific artistic productions. Indeed, artists who are willing to engage in this direction should be aware that curators, critics and historians are unreliable partners. Within the exclusive world of contemporary art and the even narrower world of new media art, trends come and go as the wind blows. I believe that every artistic activity should be carried out following one's own passions and according to one's own experience and research. After all, contributions to society are not only achieved through confrontation. The long history of generative art provides a multiplicity of concrete examples and useful applications. In this sense, I would like to conclude by returning to a seminal text by Lucy Lippars, who lucidly analyzed activist art during the eighties. "As many have discovered, it is impossible just to drop into a 'community' and make good activist art. The task is specialized (though not in the same ways high art is) and it demands discipline and dedication (as high art does). To be out of touch, unanalytical, or uninformed is disastrous"[21]. This appears to me to be a very simple but sound recommendation for any artist, not only those involved in political themes. In the end we should always keep in mind that regardless of whether the issue is generative art, new media art, or contemporary art, what matters most is the art itself and the ways it challenges our vision of life and society.

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Paper/Installation:

OBSTACLE/FLOW: interactive presence project

Topic: Art, Generative

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Abstract:

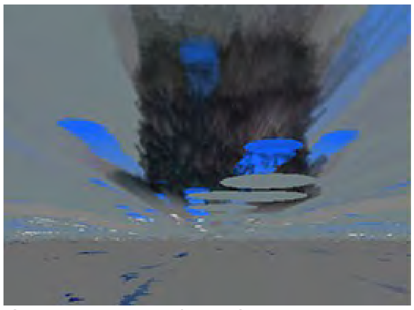
In this paper we will present the motivation and underlying research involved in the realization of our interactive collaboration, *Obstacle/Flow*. We will give an overview of the work's conceptual approach and describe the connections between the generative nature of the work and the interactive interface. We will also contextualize the work within a broader survey of related works including examples of fluid and water models, interactive sound installations and 3-dimensional (3D) dynamic terrain generation.

Obstacle/Flow's primary inspiration is the natural phenomena of *jökulhlaups*, the Icelandic term for glacier-burst. *Jökulhlaups* refers to a sudden flood-release of melt water from glaciers and ice sheets. This is realized within the work by generative elements that include: audio that sonifies invisible obstacles, small particles that aid in visualizing flow data, and exploding images of ice governed by random bursts of particles.

Random and changing variables of particle flow and obstacles create an unpredictable and dynamic audio/visual environment. Bursting ice imagery is able to dislodge the invisible sonic obstacles. As the user engages with the environment, she is gradually able to locate the obstacles. Sounds of flowing water are positioned in the stereophonic scene according to obstacle locations. These sounds are spectrally and dynamically processed so as to produce distinct sonic imagery for each obstacle. Within the virtual environment *Obstacle/Flow* creatively incorporates temperature, gravity, depth, turbulence, speed, drag, and burst force to create an immersive experience.

We present several potential future directions for *Obstacle/Flow* including additional planned interaction paradigms and user contributions to the environment. The development of *Obstacle/Flow* was supported by the Ammerman Center for Arts & Technology at Connecticut College.

Jökulsárlón, Iceland. 2011



Screen capture from Obstacle/Flow

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Keywords:
Narrative, Vignette, lived experience, design, supervision

OBSTACLE/FLOW: Interactive Presence Project

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Abstract

In this paper we will present the motivation and underlying research involved in the realization of our collaboration, *Obstacle/Flow*. We will give an overview of the work's conceptual approach and describe the connections between the generative nature of the work and the interactive interface. We will also contextualize the work within a broader survey of related works including examples of fluid and water models and interactive audiovisual work.

Obstacle/Flow's primary inspiration is the natural phenomena of *jökulhlaups*, the Icelandic term for glacier-burst. *Jökulhlaups* refers to a sudden flood-release of melt water from glaciers and ice sheets. This is realized within the work by generative elements that include: audio that sonifies obstacles, small particles that aid in visualizing flow data, and exploding images of ice governed by random bursts of particles.

We will present several potential future directions for *Obstacle/Flow* including additional planned interaction paradigms and user contributions to the environment.

1. Background and Motivation

The authors have been working collaboratively on a number of interdisciplinary projects under the auspices of the Ammerman Center for Arts and Technology at Connecticut College (New London, CT, USA). The mission of the Center is to facilitate creative collaboration and experimental investigation at the intersections of Arts and Technology, forging interdisciplinary partnerships and creating opportunities for students and scholars to think outside of disciplinary boundaries.

Over the last ten years, the authors have worked on several interactive and generative audiovisual installation pieces featuring poetry, video processing, sound and audio processing, virtual reality exploration and intelligent agent-based software.

The current work developed from, and extended, a recent site-specific project by one of the authors that focused on connections between personal place-based narratives of Iceland citizens and the dynamic and unique landscape of that country. Struck by the ubiquity of ice-covered volcanoes that make the dynamic and unpredictable phenomena *Jökulhlaups* a common term of reference and experience, the authors sought to model and explore this powerful natural force.

To being with, we established a set of core guiding principles that would govern our investigations. These included:

1. A desire to connect the experience of this dynamic natural phenomena to identifiable behaviours within a virtual space, and

2. To develop agent-based models applied to generative visual art that are creatively inspired by glacial-burst motion behaviours, and

3. To iteratively develop and refine emergent visual behaviours that develop within our work and connect them to data-driven audio processing of natural sounds.

2. Dynamic Landscape: *Jökulhlaups* and Iceberg Flows

One of Iceland's many unique and fascinating features is that many of its volcanoes are covered with ice. Because of this, when volcanoes explode, the ensuing behaviour is mysterious and hard to predict. Ash and melt water form under the ice cap. After some amount of time, this mixture finds its way out of the ice cap (Figure 1), and the sudden release of force dramatically alters the landscape below. Even after the eruption, no one is quite sure what will happen next and in which direction the water will flow.

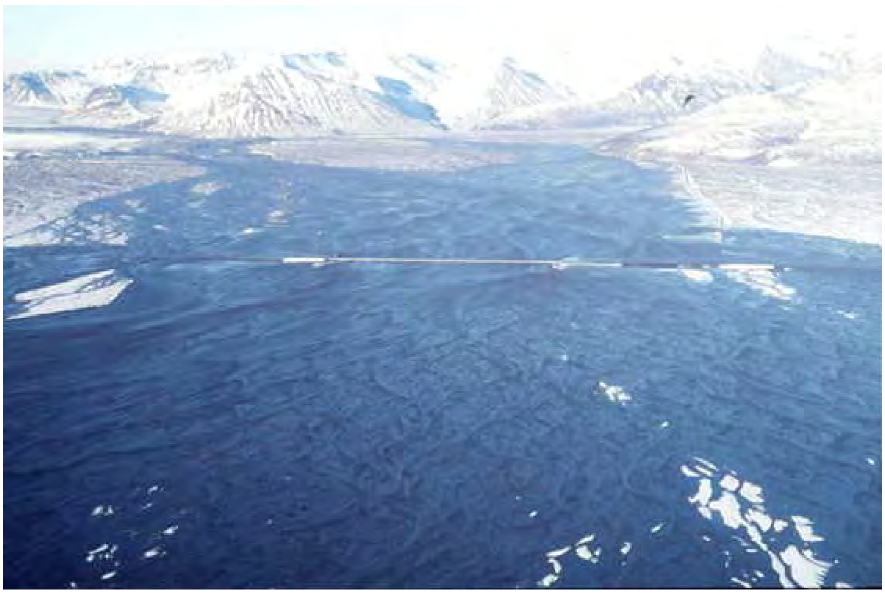

Figure 1. 1996 Iceland Jökulhlaup: subglacial eruption on the Vatnajökull ice sheet.

In addition to modelling the behaviour of *Jökulhlaups*, the authors were motivated by another common sight in Iceland — the small icebergs that break off from the ice caps during summer months and flow down rivers to the ocean, periodically running aground and colliding, and then clogging beaches until they melt or drift away (Figure 2). Within *Obstacle/Flow,* it was decided to use this iceberg spawning and lifecycle model as the inspiration for the physics-based obstacle interactions and collisions.

Figure 2. Ice released from glaciers, Jökulsarlon, Iceland 2010. Andrea Wollensak

3. Related Work – Inspiration

In addition to being inspired by the natural phenomena described above, *Obstacle/Flow*'s use of fluid dynamics, particle effects, interactive controls and audiovisual effects were influenced by both scientific and artistic models.

3.1 Fluid Dynamics

For *Obstacle/Flow*'s fluid dynamic behaviours and artistic representation, we were motivated both by recent development in software-based real-time fluid dynamic visual modelling as well as selected new media works featuring fluid elements.

Software fluid dynamic simulation has been driven in large part by developments in gaming and graphic processing unit (GPU) programming, for example Jos Stam's *Real-Time Fluid Dynamics for Games* paper based on Navier-Stokes equations which inspired Memo Atkin's open-source real-time fluid simulation library for Processing (Java) and openFrameworks (C++).

Artist Char Davies has created a number of immersive pieces featuring entrancing fluid textures including *Osmose* (1995). In *Stream* (1991, Figure 3), Ms. Davies made a series of computer-generated still images, produced by creating 3D models in virtual water-like space and then moving the computer's camera to capture the desired framing. In realizing Obstacle/Flow, we were inspired by the artistic use of fluid-based textures that Ms. Davies employed to dynamically enrich the synthetic landscape of virtual space.

Figure 3. Char Davies, Stream, 1991 digital print from The Interior Body Series

3.2 Particle Effects

Particle Effects have been used extensively for CGI and games to generate realistic explosions, trails, smoke and other dynamic transient effects. Particles are often combined with agent behaviours and simulations of physical forces. In *Obstacle/Flow*, particles interact with obstructions, are subject to physical forces and fluid simulation, and follow the contours of 3D-surfaces towards the viewer. We were inspired by artworks that contain playful uses of particles such as Camille Utterback's *Text Rain* (1999). Additionally, since we were using the software environment Processing, we carefully reviewed many of the tutorials, examples, and art work found in the Processing web site and exhibition area [1].

3.3 Interactive Features and Audio

In the past, the authors have collaborated on a number of interactive audiovisual virtual environments and installations. For ***Obstacle/Flow,*** we decided to allow the user to trigger Jökulhlaups and to trigger the creation of randomly placed obstacles in the virtual landscape.

In previous works the authors have examined the ability of the user to control the interaction through gestures and movements (in works such as DEEP/PLACE [2], Red Ball [3], virtual conducting [4], dance pedagogy [5]). Various input devices have been used in these works, including gloves, sensors, Kinect, motion capture and even haptic. *Obstacle/Flow* represents the first time the authors have used the Processing java-based programming framework for rendering the visual environment and handling user interactions, incorporating them more closely with the random and generative processes used to spawn entities and influence their behaviour.

The authors have long been interested in the interaction of the various senses in determining a user experience. In particular, audio has occupied a significant place in these considerations. Thus, for example, the authors have investigated the role of audio in way-finding [6], on how the conductor's motions influence ensemble performances [4], in the design of interactive multi-modal objects and the effects of multi-modal interactions in virtual environments [7, 8, 9, 10], and in cross-modal generative presentations [11, 12].

4. Generative Art Processes

A high-level taxonomy of Generative Art [13] typically distinguishes three major categories (Figure 4). ***Ordered*** approaches use deterministic and/or rule-based procedures as creative methodology, and include data visualization mappings of data sets to visual structure and parameters. ***Disordered*** approaches make use of non-deterministic randomness, probability and distributions to control and influence actions. ***Complex*** approaches contain both ordered and disordered processes and are typically characterized by the potential for unexpected emergent behaviour, such as many of the notable objects of Chaos Theory and aggregate agent behaviours such as swarming and flocking. Artwork that is *interactive* offers additional possibilities for allowing user input and gestures to influence these generational processes.

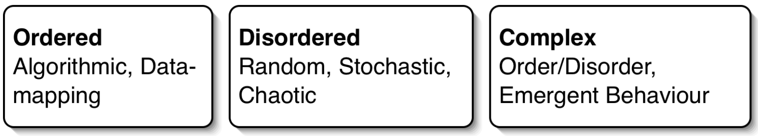

Figure 4. High-Level Taxonomy of Generative Art Processes

Obstacle/Flow makes use of these approaches as follows:

- Ordered physical simulation of fluid dynamics (producing current in which the particles move).
- Random parameters used to place particles and construct obstacles in the flow.
- Random associations between sonic resources, parameters and the obstacles.
- Ordered and chaotic behaviour to produce the obstacles, resulting in emergent forms.
- Probabilistic methods that govern the spawning of particles and add noise and jitter to their movement (in addition to the physical forces acting on them).
- Interactive user interventions to spawn Jökulhlaups burst behaviour, associated ice-oriented imagery and to generate new obstacles.

5. High-Level Obstacle/Flow Structure

Figure 5 shows the high-level structure of the *Obstacle/Flow* environment.

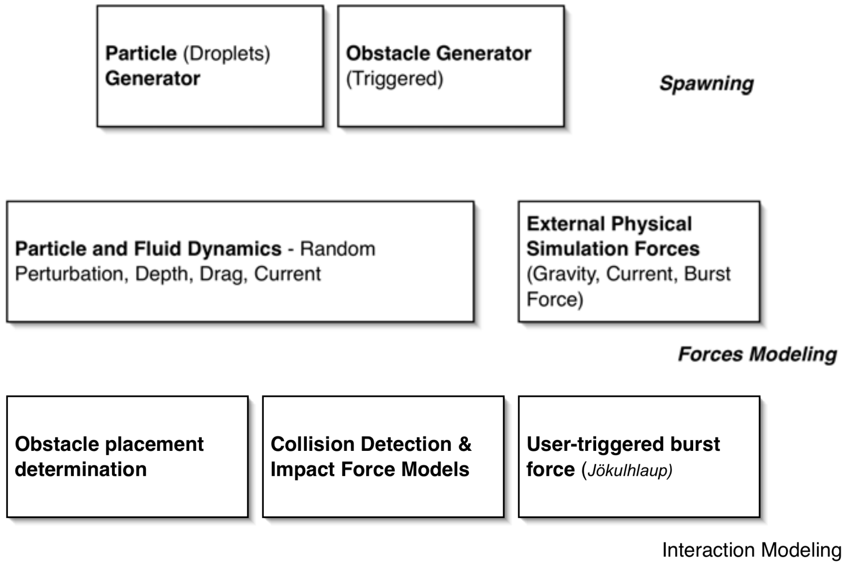

Figure 5. High-Level Organization of Obstacle/Flow Simulation models

The three main layers of the *Obstacle/Flow* architecture can be characterized as:

- *Spawning*—rules that govern the creation and initial characteristics of particles as well as the rules that govern the creation and initial characteristics of obstacles.
- *Forces Modeling*—the forces that act on the particles can be broken down further into the dynamic ways in which particles respond to their environment, the movement and simulation of the fluid, and the presence of physical forces.
- *Interaction Modeling*—the ways in which user-controlled interventions (burst behaviour and obstacle creation) and entity interactions (collisions, bursts, exiting the boundaries of the virtual environment) are realized.

6. Generative Components

The 3D environment represents the flow of water in a river, punctuated by Jökulhlaups, and populated with ice obstacles. The entire environment is also informed by audio that is associated with the ambient environment and localized to, and influenced by, the ice obstacles. Droplets of water advance toward the user, leaving a memory trail; as they encounter the ice obstacles their flow is diverted. The force of droplets hitting individual obstacles causes the obstacles to move downstream. Bursts of Jökulhlaups cause ice particles to be released; Jökulhlaups are also characterized by images that fill the screen and then explode.

Figure 6 shows both the droplets and the presence of several ice obstacles. The user's point of view is from a position in the river, considerably downstream from where the droplets start their journey. The user is able to control certain aspects of the environment, for example, triggering the occurrence of a Jökulhlaup, optionally constrained to appear in certain zones of the screen.

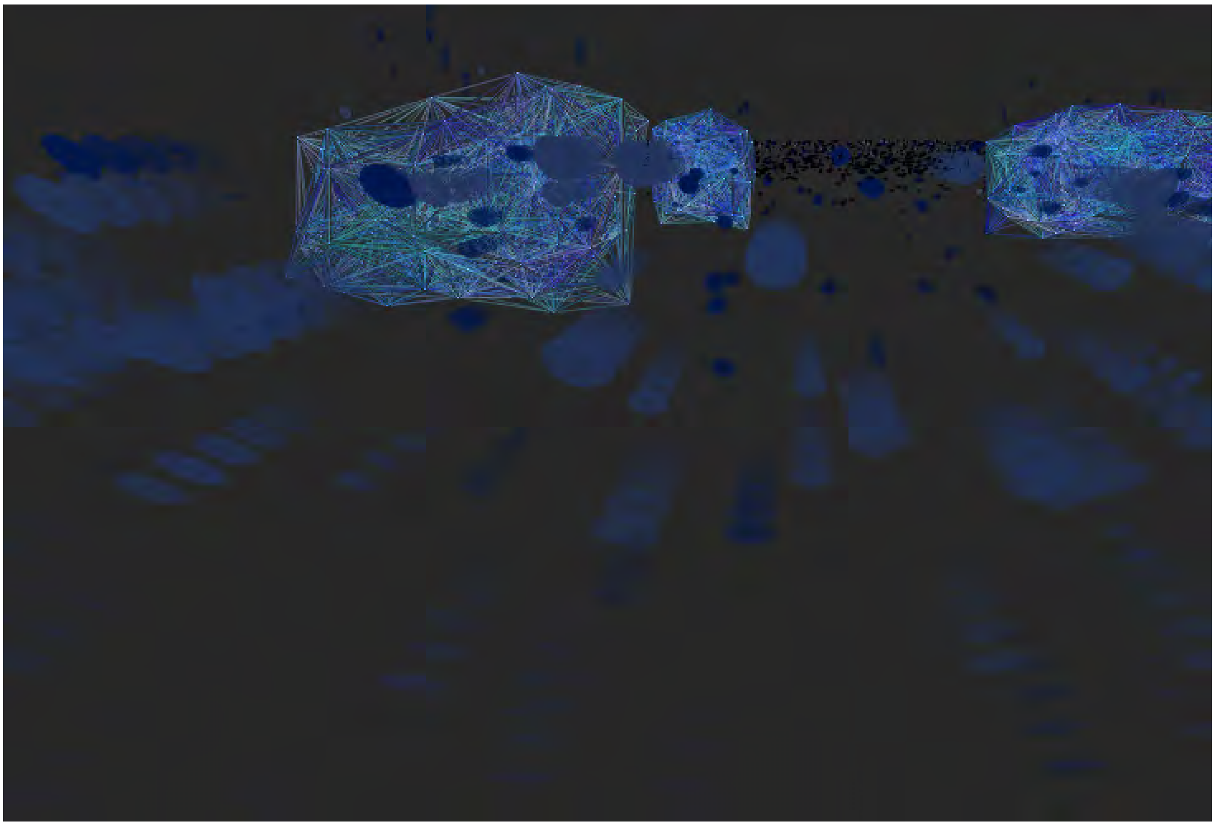

Figure 6. Image capture of Obstacle/Flow virtual environment showing three obstacles and droplet particles moving towards the viewer

6.1 Water and Ice

The two main generative components are the spawning of droplet particles and the spawning of ice obstacles. Droplets are represented by ellipses with randomized dimensions and randomly determined locations in 3D space. The initial placement of droplets is weighted so that there is a greater probability of originating near the center of the virtual space. The size of each droplet is also determined by a random procedure and constrained within a specific range. The droplets are released in a systematic fashion. When a Jökulhlaup occurs, bursts of additional droplets are formed in a similar fashion. Their density is probabilistically determined to reflect the bursting action of a Jökulhlaup.

Ice obstacles are also spawned in a generative fashion. They are constructed by (1) randomly placing primary points in a box, (2) randomly selecting additional points near the surface, (3) moving points along a line joining the pairs of points and then (4) connecting pairs of primary points that are within a select distance from each other. The constantly changing locations and their periodic random movement to other locations create dynamic fluid behavior that evokes both the rigid and the fluid characteristics of melting ice. The dimensions of the obstacle, the color of lines joining primary pairs of points and the location of the obstacle are also random, within certain parameters controlled by the user.

6.2 Physics of Environment: Flow, Terrain and Obstacles

Principles of physics ground the behavior of both obstacles and droplets. Just as the idea of Jökulhlaups inspired the creation of the piece of generative art, the principles of physics provide a foundation for the environment. Both of these ideas are crucial to the vision of the collaborators and provide a touchstone for the artistic components.

Particle and fluid dynamics control some aspects of the flow of droplets. Gravity, current and the terrain affect the speed at which the particles flow; droplets are also subject to perturbations and to friction. The closer the particles are to the river bed the stronger the drag on them. The depth of the particles above the river bed influences their transparency. As each particle descends the river, it leaves a disappearing trail of previous positions. Droplets also interact with the obstacles. As droplets hit an obstacle they either pass through (if their size is small enough) or they are forced to go up along the surface of the obstacle, travel across the top and then descend on the other side to the depth originally assigned to them. At this point their velocity starts from 0 and progresses according to gravity and the terrain.

The ice obstacles are also grounded in principles of physics. As droplets hit an obstacle they begin to cause it to move down the river. The number of droplets needed to move the obstacle is a function of the size of the obstacle (which is randomly generated). Then as an ice obstacle begins to move it obeys the laws of gravity and the terrain beneath it, picking up speed as it descends. Figure 7 shows an ice obstacle about to move beyond the viewer.

6.3 Obstacles and Sound Field

The sound system consists of a layered architecture to model water and ice-based phenomena specifically during Jökulhlaups. The sounds are produced in four separate layers, each serving a different purpose.

The first layer consists of continual ambient sounds. These form the substrate of the soundscape and mostly consist of natural sounds. Accompanying the continual sounds are rare ambient sounds that have starting times triggered by Jökulhlaups. These represent large-scale, but rare events, such as eruptions and displacement of large bodies of ice. Their presence is correlated to the overall water activity.

The third layer consists of localized sounds organized in a generative sense with each sound being driven by the properties of the visual obstacles. In this layer, each obstacle sound is composed of many overlapping sound grains whose density, volume and location are controlled by the location of the obstacles and their proximity to the viewer. For example, figure 7 below shows an obstacle about to pass the viewer and the localized sound for that obstacle will reinforce that proximity. In order to enrich the sonic scene and make it more accessible to the viewer, obstacle sounds are designed to have differentiable sound textures.

The sound grains are of varying length and different for each obstacle. They are organized on-the-fly to depict the intensity of the flow of water as experienced by its associated obstacle. In addition to the three general parameters for each obstacle sound, the grains that make up the sound are also internally randomized to obtain a range of gain and pan values around their target values. Similar to the third layer, sounds in the fourth layer are controlled by the location of the visual obstacles and proximity to the viewer, but in this case these affect the sound filtering parameters. The sounds in this layer are filtered abstract, noise-like sounds. Time-varying filters allow spectral modifications to take different forms according to the obstacles' properties.

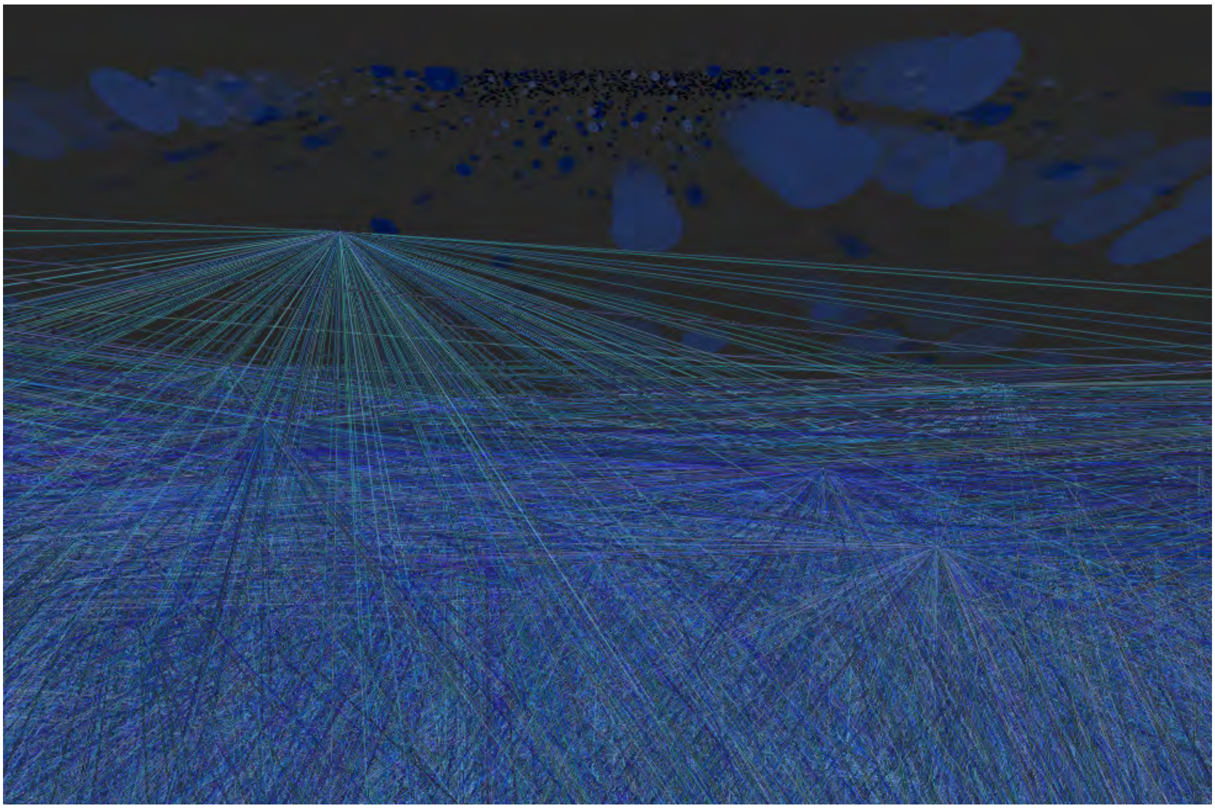

Figure 7. Obstacle form leaving screen

6.4 Jökulhlaups

The user is able to cause a Jökulhlaup with a key press. When this occurs there is a burst of ice particles at the top of the screen. In addition, to help depict the explosive nature of this event, an image related to such an event is randomly chosen from a collection and it appears on the screen, filling it up. Then, very quickly, the image explodes into a 3D world, moves toward the viewer and disappears. The image is divided into blocks of pixels, each colored with the original tint and whose z-position is determined by the brightness of the pixels (thanks to Daniel Shiffman for this idea). In Figure 8 below this phenomenon is illustrated.

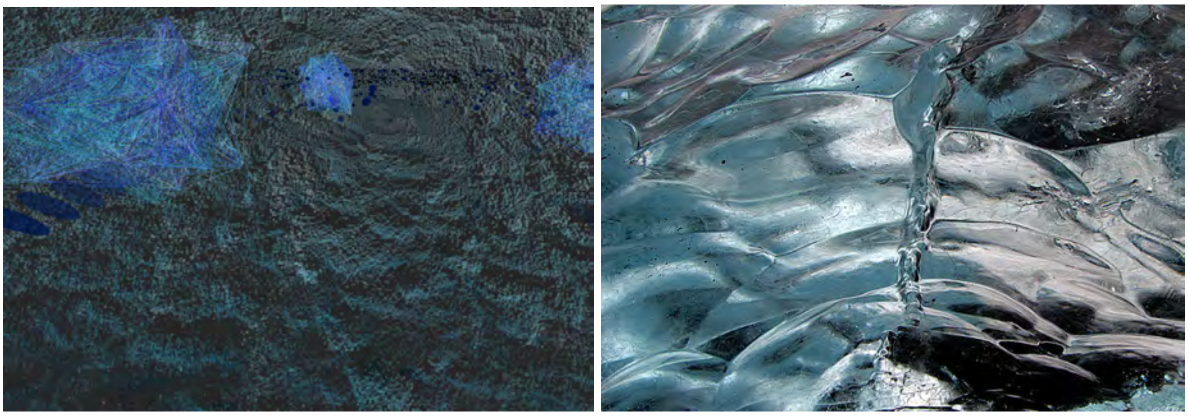

Figure 8. Jökulhlaup image burst and source image

7. Summary and Future Directions

This collaborative piece of generative art is grounded in natural phenomena and natural sounds. But then it uses the flexibility of the digital to create a more randomized, unpredictable and abstract interpretation of these natural phenomena.

Additional plans for this environment are to give the user more control over the speed and density of the droplets as well as more control over the ice obstacles' size and behaviour. Future plans include developing this project as a projected video installation where the user is able to control the events through gestures tracked by devices, such as the Kinect, that conveniently help acquire depth and image information. In addition, the viewer would herself become an obstacle and droplets would move around her. Another version could involve 3D viewing and spatialized audio to increase user immersion.

Acknowledgement
The authors would like to thank Donald Blevins, Fellow of the Ammerman Center for Arts & Technology, for his assistance.

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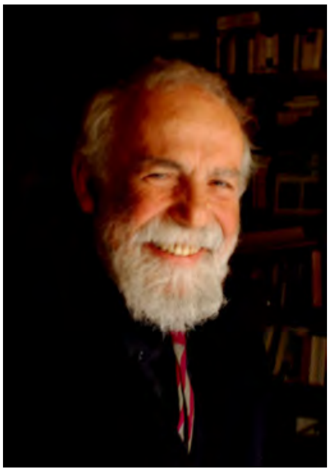
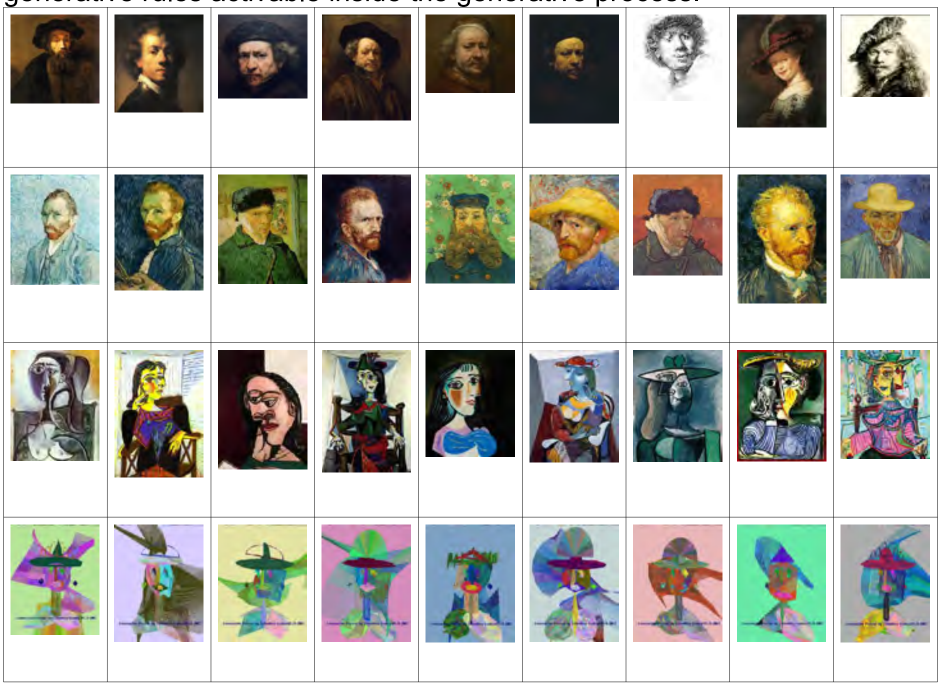
Celestino Soddu

Paper : **Generative Art performs the Artist Style as Executable Process**



Abstract:
looking at a sequence of artworks we can immediately identify which artist made it. But only if the artist imprinting, the artist style and unicity exists.
Make own arworks recognizable as belonging to a peculiar and unique style is one of the character of each artist work.
One of the main opportunities of Generative Art is to work on defining his own style, clarifying step by step the strong relationship between own imaginary and the clear recognizable imprinting in the generated artworks.
This paper will identify how to manage own generative process and how the results could be identified as variations inside the same style. More, how generate unique and unrepeatable events as each arworks should be.
Question are related to:
> the concept of identity of the style but also identity of each artworks
> the concept of variation, the main road to perform well identifiable imprinting
> the complexity, in the generative process and in the artworks, as character to improve the recognizability of own imprinting using the casualness of the inputs from the environment
> the use of random and unpredictable starting point, or the use of random inside the executable process.
> The difference between random results and impredictable results owing to the management of generative processes.
Finally, some basic considerations for transforming own imaginary into generative rules activable inside the generative process.



Portraits: the recognizable artist imprinting in the history of Art. (Rembrant, VanGogh and Picasso, and my attempt to generate variations of women portraits referring to my interpretation of Picasso.

Topic: Generative Art Approach

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Keywords:
generative, artworks, identity, variations, complexity, casuality & random, imprinting, style, recognizability, clarity

Logics of Imagination

Generative Art performs a Style as Executable Process

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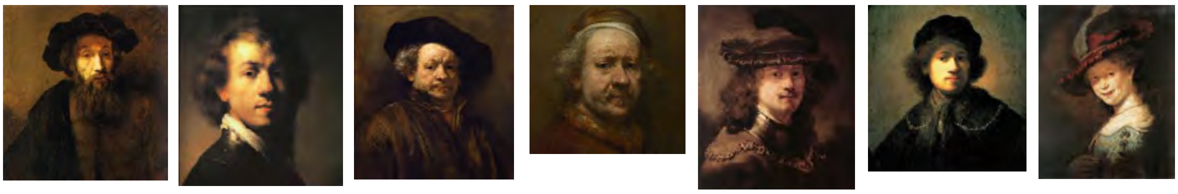
Van Gogh, a sequence of landscape “variations”. We recognize his imprinting at the first glance. Rembrant, a sequence of his portraits. where imprinting is immediately recognizable



Premise*. Logics of imagination, some considerations*

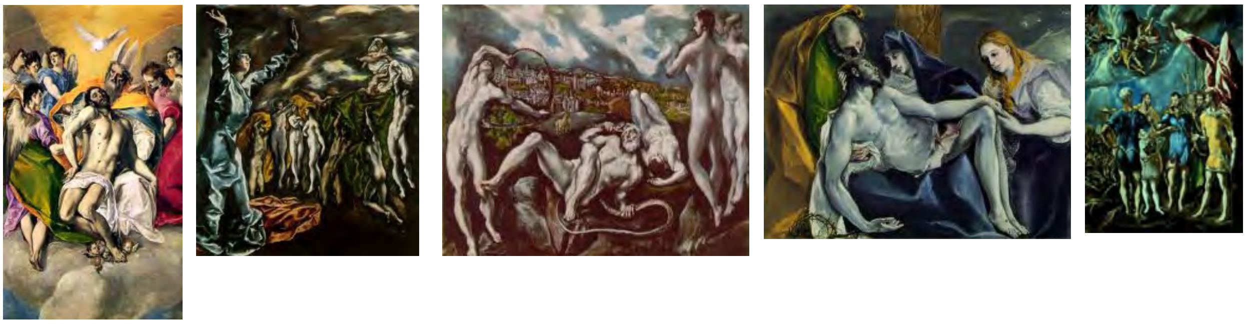
From a photo of a flowerpot with sunflowers to a painting of Van Gogh there is a transforming process as an increasing identity; together with a recognizable feeling. It is not an analytical process but a transforming process based on logics of subjective interpretations: t*he logics of imagination*. The same process that we can find in each scientific discovery path.

If we look at a Van Gogh painting and at a painting of Monet, all showing a flowerpot with sunflowers, the underground process appears different. There is a different observation, a different feeling or, we can say, a different imprinting able to generate a different style.

The conceptual frameworks and the creative processes are different, because the transforming process is different: How the stem folds, how the petal ends, how the flower is divided, how....how... how . It is a discover following an observation for defining an hypothesis as a subjective identification of a possible “generative” process. Art/Science is interpreting what exists for transforming/representing it into an artwork/idea/scientific hypothesis.

A photo of sunflowers, Vincent Van Gogh and Claude Monet paintings

As we can suddenly recognize, without any doubt, the paintings of El Greco



How the bodies fold, how each people lands, how the arms involve the space, how.. how.. how . There are several possible subjective interpretations of the characters of El Greco representations. In any case we recognize them as belonging to El Greco so we identify the characters that fit our own imagination.

50 years ago, before the computer era, was used a term, *metadesign*, for identifying a peculiar creative process. Metadesign was used firstly by Adrien van Onck in 1963 for identifying the moment when an idea can develop itself before any possible subsequent final result. And the use was not limited to the design processes but involved other fields of Art. The problems were that, in that years with no computers, no tools able to execute a sequence of orders (In Sanskrit old language, Art is *Are* and means ordering) it was impossible to carry out a meta-artwork able to really work for producing artworks.

The aim was to create something like the project of the possible projects, the meta-artwork of the possible artworks with the ability to identify the character of these possible results. This metadesign needs to use the abstraction, that cannot be a simplification owing only to the theme, functions, tools, forms and so on. The used abstraction must have a high level of definition of own vision able to be correctly used for performing the character of each result. Today, after our experience in GA, we can say for generating different but well identifiable multiple results.

In other words meta-artwork is the first identification of what today we can call Generative Artwork. Or, adopting the biological language, the artificial DNA of each possible artworks of an artist.

How we can first identify, second create and then make usable a Generative Artwork? By performing it as a conceptual framework constructed as executable process. You can do that in different ways: with a set of algorithms inside an original program, or with a mechanical, chemical or biological device able to run a complex process of subsequent transformations and increasing complexity.

The common aspect of these processes is their being dynamical, complex, not-linear systems.

It's arguable that these processes include two different parts: the subjective creative approach (the style) and the organization of the theme / precedents (the sunflowers in the previous example). The first is similar to a DNA code, the second is the logical subjective observation of the contingent occasion for performing artworks.

As well as DNA in nature, the first part is a set of multiple and different logics of transformation. Each code could be identifiable as able to represent, create and enhance a peculiar character of what exist before, able to perform a recognizable aspect of the artist style.

The second part focuses the subjective point of view used for acquiring the environment. In fact for reaching the searched results, it controls the structure of each possible topological interconnection and possible contaminations among the multiple and parallel transforming processes.

The character of this creative framework is the high level of not-simplified abstraction that, referring to Nietzsche concept of Art, create a dynamical level of complexity where the possible meanings are infinite, and where the forms could be considered as possible interchangeable formal matrices (C.Soddu, Citta' Aleatorie, Masson Pub. 1989) inside a well identified framework belonging to the artist vision.

In these last decades, with the Generative Approach and with the help of computers able to keep in memory and put inside an executable process our multiple and subsequent key of observation, we can work directly inside the increasing complexity process of the creation of a peculiar style. Because we can work inside the core of this dynamic system in the moment of its construction, applying in progress a sequence of our logics of imagination by following our subjective and contingent point of view.

Some consideration about "new"

New things, new forms cannot exist. If we are looking for a new form, we cannot go over the existing forms. The "new" belongs to possible complex transformation processes. The "new" belongs to an interpretation, a tendentious open observation of already existing events.

Many times, the transforming process is expressly applied to another existing artwork of another artist, increasing the sequence of subsequent interpretations. We can see this process in Picasso following Velasquez. Picasso interpreted the portraits of

Velasquez, particularly the "meninas", for constructing his own portraits, his own "style" that is strongly unique and identifiable, so strongly recognizable. A style that is without doubt "new", but coming from the interpretation of already existent artworks. It is new because the process is new, being a not-analytical process but a discovering not-linear path as new imaginary logics.

Forms are not an essential matter in creating a style and subsequently, their identity are not essential in the core of a generative process. They are only interchangeable possibilities that we use for managing multiple exits of a creative process. In the multiple variations, the formal matrices identifies each single result, not the species of results and consequently the style.

New is never new as a form, but as a new interpretation. As it happens in scientific discoveries.

The "new" style happens when the artist identifies own set of interpretative logics and related feasible devices being able to make them executable. Quoting Focillon, each visionary artist builds his own tools, not his own forms.

Velasquez, “las meninas” , a detail and another portrait

Picasso, re-painting by interpreting many times ”las meninas”

by Velasquez

In Generative approach, each generative artist builds his own logical imagination with his own tools. It's difficult to be a generative artist without constructing his own software or other executable devices.

First part. Generative Art and logics of imagination

Basically, all the Ideas are generative matters. Each one could be identified in the progressive process for generating the future from the preceding events.

The style belongs to the complex system identifiable in interferences, contaminations and reciprocal similarities and symmetries among multiple logics. This complex set of rules and their reciprocal relationships comes from our own imaginary It constructs an evolutionary code, a modus-operandi, able to characterize and make unique each act of an artist.

The Generative Process is constructed as a labyrinth, where each time we use it, we can run a different path by using, in different sequence, the same doors of transformation.

Using algorithms, the generative approach allows us to easily perform this system because we can create the transforming doors, one after the other, following our multiple references to our imaginary. We can design them with no care to their mutual relationships leaving open different possible interferences and contaminations with parallel algorithms. In this phase the only aim is to fit each peculiar character that we need to have in our artworks. So we are constructing our style. We can operate several different abductions from our imaginary, focalizing them as logics of transformation, without any need of choice but only for fitting our "style".

Only in a subsequent moment we can put them into a logical paradigm able to promote the mutual contaminations, interrelations and symmetries. We can identify the theme of our possible artworks by structuring the control paradigm of such interrelations able to manage in progress the topological structure of our observation and of our preferred references. More, as I normally do in my generative software, I fix the usable doors but I link the sequence of some of these doors to the time of beginning of the process. In other words, as happens in all chaotic systems, the flight of a fly, in this case the different starting moment of the process, can change the weather in the other part of the world.

The great possibility offered by the generative approach is the construction of own unique style with subsequent steps, by creating and modifying in progress the structure of synthesis that will perform the progressive attainment of complexity and recognizable clarity.

Complexity is necessary for attaining the wanted identity. Each single interpretative logics, or a simplification of these logics cannot succeed in going over a copy or an emulation of already experienced. The increasing of possible logics, parallel different logics oriented toward different characters and adjectives, also as alternative logics, creates the necessary complexity for moving from a linear system with predictable results to a not-linear complex system, with chaotic structure. Where we can find progressive bifurcations and, quoting R. Thom, unpredictable uniqueness and catastrophes.

With its border of casualness inside the choice, each bifurcation increases the complexity, pushing the process toward the exploration of possible. But only if the generative process will be so complex to manage these unpredictable events as increasing identity of the style. As happens in our life, where the catastrophes can enhance our identity if we are strong enough to manage them.

The high level of complexity, and therefore a critic mass of algorithms that can work in parallel, is necessary for performing Generative Art.

Second part. Identity Codes

Just a path around possible fields for identifying own identity codes, own logics of imagination and dropping them into an executable process. For instance, by using interpretative relationships between different dimensions, or using different geometrical points of view, or multiple perspective points of view, and so on.

Images of medieval cities by Simone Martini (1 and 2) and Giotto (3)

A sequence of generated medieval cities (C.Soddu 1989) in a painting of Simone Martini.

I used, as reference imaginary, the medieval artworks by Simone Martini and Giotto. I made this choice because they are meta-perspective representations. So they can be interpreted as dynamically fragmented perspectives along an interpretable time. Quoting my book "The not Euclidean Image", Gangemi 1986, the paintings of Simone Martini can be logically interpreted as a dynamic movie along a path from outside to inside the represented medieval city. Using this interpretation and moving from the time-dimension to space-dimensions, it's possible to manage progressive transformations from the existent city to its representation. This can give a dynamic unique character to the results, the same character that we appreciated in these frescos. These transformations can be used, performing appropriate algorithms, into a generative process. As I done for my first Italian Medieval Towns Generative project (1988).

We can find in Picasso a similar field for developing own interpretative structure. He used the possibility to perform together several different points of view, as Simone Martini done. But the Picasso process uses this multiple points of view for “exploding” the painted object. This defines his imprinting.

We can find in Balla, and in other futuristic painters the same field of interpretation but with completely different characters and results. In Futuristic paintings the presence of different points of view and related facets is not own to the interpretation of the discovery path of the space but to the representation of the speed of this progressive discovery.

Balla Futuristic, the speed representation.

In Van Gogh paintings the transforming process related to the multiplicity of points of view is completely different, and unique. Looking at the painting of his own room, we can identify two different and conflicting perspective visions. (C.Soddu, "The not Euclidean Image", Gangemi 1986). The perspective view of the room uses a point of view from top down. But the structure of the perspective representation shows that the look is not from top down but, on the contrary, bottom up. This communicates multiple conflicting feelings that are one of the character of his whole opera. And of his unique and unmistakable style.

Van Gogh. His room in the original image (1) with the contamination of two different points of view and a transformation to a “normal” perspective (2) that looses the unique character, style and feeling of the original painting.

We can find in the artworks of Piranesi the same multiple points of view, but with different logics. In his engraves, mainly the "Le Carceri d'Invenzione". Piranesi represents the far objects by changing the rules of the perspective, by moving forward the point of view. The result is that these objects are magnified. More, he progressively slides, just a bit, the point of view on the right or on the left. This transforming logics give to his opera the unique imprinting, a strong uniqueness and identifiable clarity.

Piranesi, “Carceri d'Invenzione”. In the bottom 9 variation of “Babel tower, homage to Piranesi”, C.Soddu 2008 made for the covers of GA2008 proceedings, using the same multiple sliding perspectives.

If the aim is to interpret as transforming rules some characters of our surrounding world, and to run a process able to generate representations as mirror of own feelings, we need to focalize these characters.

In our teaching activity from 1989, Enrica Colabella and I firstly ask to our students to identify these characters through three adjectives. And we ask to abduct different transforming rules from the surrounding world for each different adjective. In this way the students learn how to focalize their subjective identity and how to construct their uniqueness and style. For instance, if one of them identifies an adjective able to represent one aspect of his creative identity, of his style in construction, he tries to find out when this adjective can be found in his imaginary.

For example in the artworks of other artists that seems to perform the character of the adjective.

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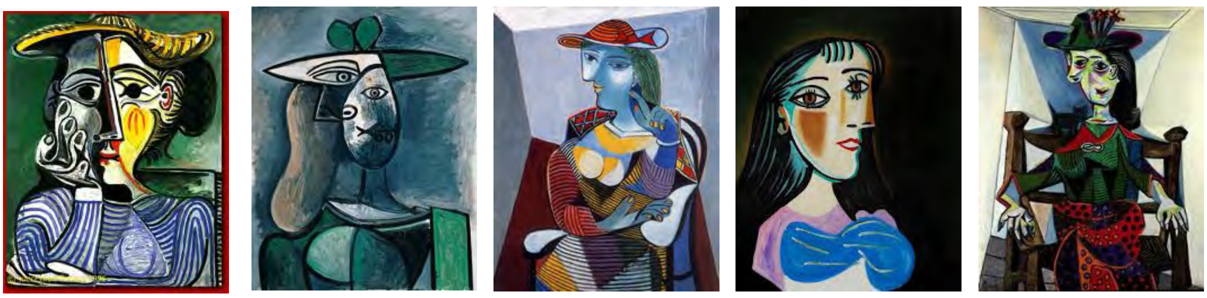
Van Gogh portraits and Francis Bacon portraits. Their logical imagination is unique and well recognizable, also if Francis Bacon made some of his paintings as “homage” to Van Gogh, explicitly referring to Van Gogh character. But he interpreted these characters following his own logical imagination.



Picasso portraits

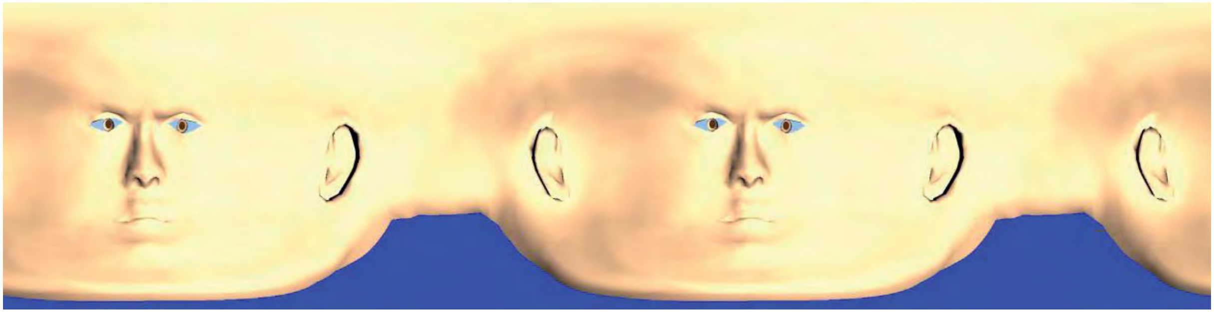
D'apres Picasso

!0 portraits of Picasso and my artwork "d'apres Picasso" (1996) with 10 generated variations made as homage to this great artist.

Interpreting the Picasso women portraits I created a generative artwork "D'apres Picasso, women portraits", able to generate an endless sequence of variations . My aim was to create variations where we can identify Picasso interpreted by my particular point of view able to focus the characters that I like in these paintings. But the aim was to represent my imprinting too. Identities can come together, as happens when Picasso interpreted Velasquez

For constructing possible interpretative codes as algorithms inside the generative process we can use, one time more, the perspective geometry tools. For instance by defining, inside the perspective representation, the variation of point of view. The example that I like to explain is the Russian Icons. These images have, following my subjective interpretation, a peculiar character, something that seems to be far but in the same time able to involve, This character is common to Velasquez and Picasso and it is designed by the presence of multiple points of view.

Faces of Saints in Russian Icons. Represented with reverse perspective.



The use of reverse perspective. The image is a perspective at twice 360 degree from the inside of the face. C.Soddu.

In the Russian Icons the double point of view is one inside and one outside the head of the represented Saint. The image of the saint is like the image of his face when it is seen from a point of view inside his head. So we can identify a double vision but, on the contrary of what happens in Van Gogh, Piranesi, Balla and Picasso, one point of view is from outside and seems to be in front of the Saint and the second one is from inside the head of the Saint improving the involvement of the observer.

This approach refers to the reverse perspective identified by Florenskji, and to the operative interpretation that I done in my article (Soddu C., 2010. Perspective, a Visionary Process: The Main Generative Road for Crossing Dimensions. NNJ v 12, n.1, Springer Pub.) by constructing the algorithm of this particular representation.

The possible outlet of these algorithms of reverse perspective into an executable generative process is in the possibility to upgrade the involvement power of the generated artworks. In my experiments I tried to define some rules of transformation by directly operate on the 3D model and not on its representation, by transforming it using anamorphosis.

By the way, many of my generative algorithms were done using transformations based of contaminations among different points of view and different dimensions. But these transforming processes operate directly on the three-dimensional geometry of each event. A movement pendulum-like between 2D, 3D and 4D that can increase the complexity of each possible result and gives the opportunity to enhance the wanted identity and its clarity and recognisability.

These contaminations between different dimensions are used in all the creative fields, not only in generative processes involving visual art, design or architecture.

In music this increasing complexity approach involves different possible points of view that we can identify as different melodic lines running together with symmetries and mutual contaminations, As well as different solos in Jazz pieces where the different subjective interpretations run together. Enhancing the style of each musician.

In Bach, in his Art of Fugue as well as in his Well-tempered Clavier fugues and in Goldberg Variations, the rules were rendered explicit by the structure of the counterpoint. The logical structure of counterpoint seems to be univocal but, as it's possible verify in many different theories about counterpoint, are substantially subjective different interpretations of the basic rules involving the resonance between sequences, the symmetries and reciprocal contaminations.

The Bach fugues are unique and un-repeatable. Each fugue is different, all together are strongly identifiable as belonging to Bach style. It's a wondering Generative Artwork.

J.S.Bach, Well tempered Clavier Fugues. The beginning of fugues #1, #2, #3, #6, #7.

In the same way we recognize the songs of the Beatles. There are not codified rules that we can discover analyzing their songs. We can try to interpret them by constructing, one after the other, possible algorithms able to represent the different characters that we appreciate. No analytical processes can be useful. Also if we identify some relationships that seems to be useful, for instance the relations between the last two notes of a sequence and the beginning of the next one, and we try to construct an attractor, we cannot use it. It's not an algorithm, it cannot be used inside a generative process. The only way is to identify, in progress, a set of algorithms and set up this executable process until the results will fit our interpretation of the character (the subjectively pre-identified character) of Beatles music. At the end, we cannot say to have written the Beatles generative algorithms, but our interpretation of Beatles.

Third part. *Some considerations about subjectivity, casualness, variations and complexity*

The results, together, represent a set of Variations. Each result is different, unique and un-repeatable, by depending from the contingent moment or environment in which the process is running. But all variations together represent the artist idea, his own unique style.

In Generative Art there are many different ways to perform variations inside each generative artwork.

1. the environment changes-evolves each time the process will start. This can be managed by using a random number in the parameter used for starting up the process or, as I do in my generative artworks, by using the time and the date to

make the difference among all the results without having two times the same starting point.

In this way, each different starting point will identify the uniqueness of each result.

2. the environment changes-evolves owing to an external interaction made by the user. As happens in the interactive installations.

3. there is a third way to perform variations inside a single generative artwork: using the random inside the logical structure and compositive rules. This possibility could be extremely dangerous. It should be done only if the results continue to represent the artist idea, and these results are recognizable as variations belonging to the same subjective vision.

The two possibilities are:

A. Random inside the compositive algorithms manages only the possibility to use a fuzzy approach. That is the possibility to manage only a minimum variation of some parameters that can be valuated as wide tolerance, as grey margin between black and white, as fog. This approach could perform the possibility to manage bifurcations in the dynamic not-linear system of our creative process. And to manage singularities, following the concept of R. Thom. As all creative acts, the generative process, by simulating the creative process, must evaluate possible alternatives that seem, at first, to be adequate to the artist idea. Once chosen, this choice determines the subsequent ones and the uniqueness of each variation.

B. Random is used to produce main changes inside the generative algorithms or inside the geometrical structure of the generated forms. This approach performs casual results that cannot be recognizable as belonging to the artist aims. In this case we could identify the process as generative process, but it cannot be called Art because the strong link artist-artworks disappears. So it is my opinion that it's better to call it Generative (Emergent) System. We can verify it simply looking at the management of these results. Following this random approach, the artist needs to directly interact with the results by choosing the results that seems to represent his own idea and by discarding the most because they will be strongly divergent from his aims. This "final" act seems to represent more a shopping act than a creative act.

4. Variations and Complexity

Quoting G.N.Ilya Prigogine, each system is adaptive to the surrounding environment. In other terms, several alternatives are possible for the same process. Only the casualness of the context will decide which of these alternatives will be adopted. This fact gives to the system its *historical dimension,* a *memory of the past by performing the evolution*.

Complexity grows in parallel with an history. For giving complexity to our artworks we need to run a (virtual) history. Generative Artworks are virtual histories that will run everytime in a different way but with the same style.

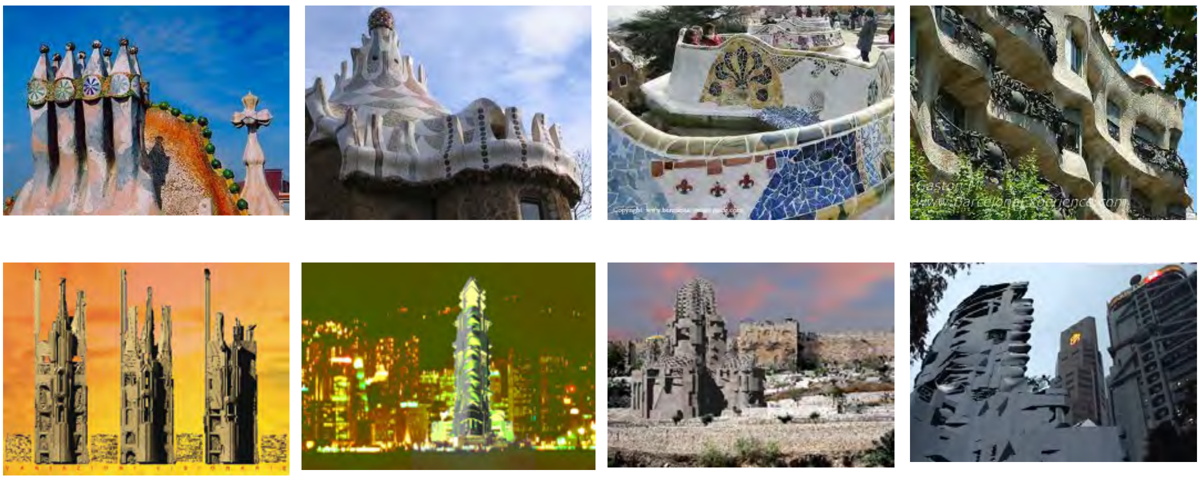
Complexity is inside the ability of generative processes to manage the unpredictability of "observed" surrounding environment. The complexity appears with the ability to satisfy not predicted expectations and un-predictable requests. So we can see that the quality of the results is not static but dynamic. This ability, proper of the generative processes, belongs to its auto-organization potentiality. It keeps alive or, better, enhances the identity, recognisability and uniqueness of the generative artwork. We can experience that:

1. More the interaction with the environment is unpredictable, more the identity of the result is high;

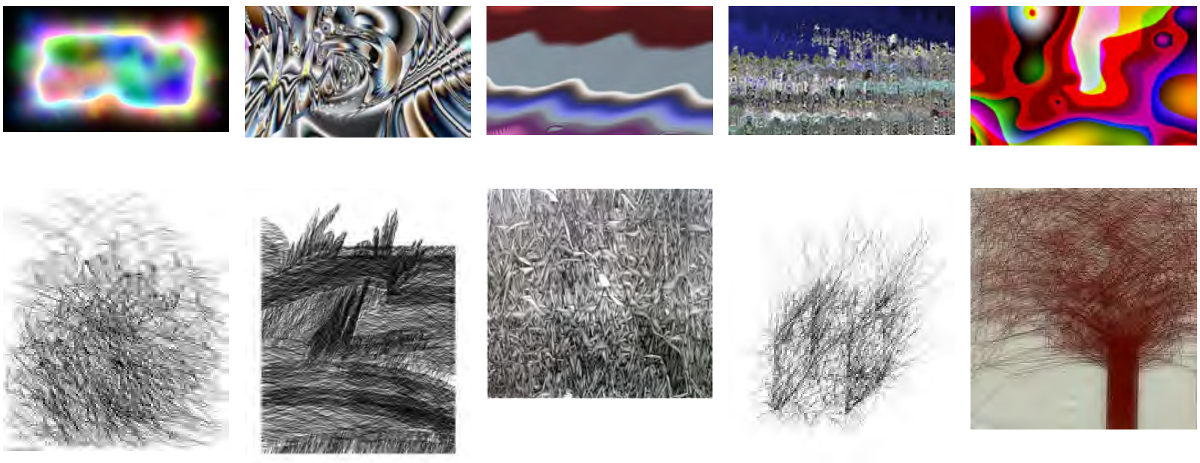
2. More the random factors involve the logical process, more the identity and complexity of the results is low;

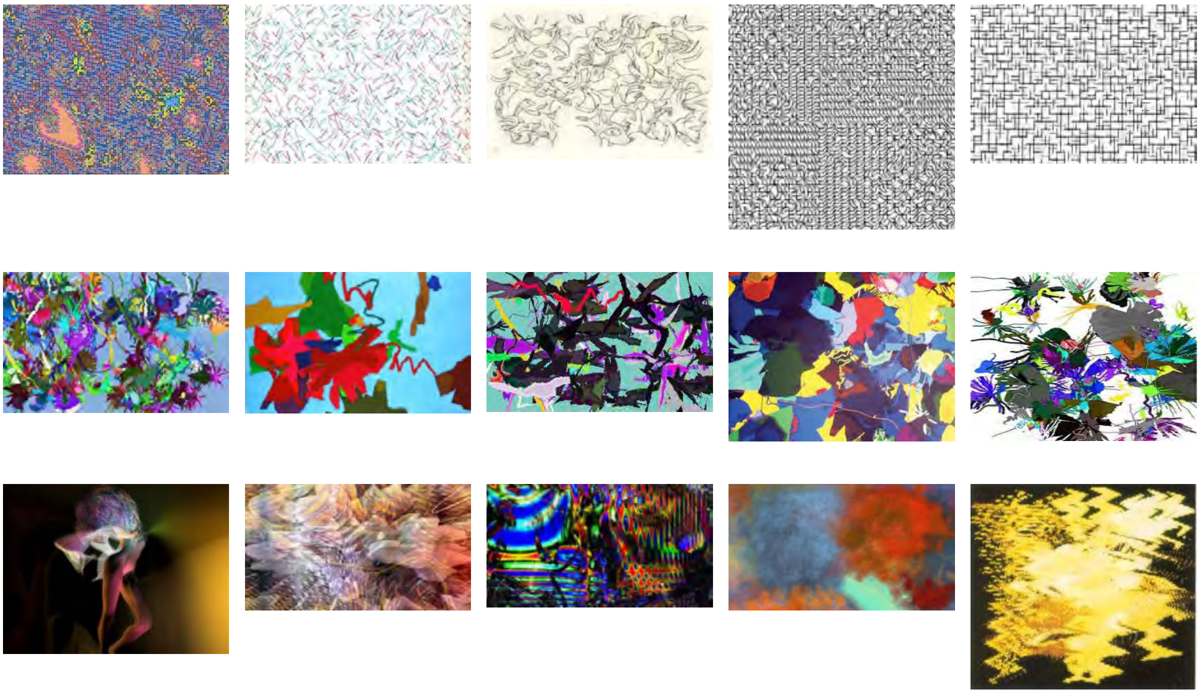
Generative Art, putting aside the Art path based on the oneness of creative acts as well as optimised single forms, can run an "open" creative path by creating a not-linear system.

This Generative Approach defines again the similarity between Art and Science. Following the concept of T.Kuhn, (the structure of scientific revolution, 1969), The generative approach is not an analytical approach but it is something similar to a scientific discovery path.



In the 1st row four images of the architectures by Gaudi, my great master, and, in the 2nd row, my homage to Gaudi together with 3 other architectures (Hong Kong, Jerusalem and Hong Kong Central) made by me referring to Gaudi.





5 artworks of generative artists like Yoshi Abe, Hans Dehlinger, Peter Beyls, Harold Cohen, Alan Lioret . The style is recognizable.

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Daniel Bisig

STOCOS – Dance in a Synergistic Environment

Abstract:

STOCOS is a dance performance that combines stochastic processes and artificial life based simulations in order to create mutual aesthetic and behavioral dependencies between dancers, simulated entities, music and imagery.

At the core of Stocos lies the notion of a synergistic environment whose physical and virtual characteristics are interrelated via simulations of natural phenomena. The environment is populated by natural and artificial entities whose mutual perception and engagement alternate between different forms of autonomy and dependency. The choreographic structure of the performance emerges from these changing behavioral relationships.

Stocos is centered on the analysis and development of gestural relationships between dancers, music and simulated entities. The activities of the dancers, music and visuals relate to each other via underlying processes of brownian movement and flocking behavior. A dense network of mutual influences emerges that establishes coherency among the spatial, perceptional and behavioral properties of its natural and artificial participants.

Stocos, Premiere, Mercat de les Flors, Barcelona, Spain, October 2011

Topic: Dance

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Keywords:
Dance Performance, Swarm Simulation, Stochastic Synthesis

STOCOS
Dance in a Synergistic Environment

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1. Introduction and Concept

Stocos represents the third part of a trilogy of dance works that experiment with gesture as a means to connect bodily movement to sound synthesis and sound spatialization. Stocos extends this focus by exploring not only relations between gestures of the human body and music but also relations between simulation based synthetic gestures and video imagery. The simulation based approach also serves as a unifying principle that underlies all the activities on stage. Accordingly, the natural and artificial characteristics of the stage arise from the interplay of algorithmic processes and thereby form a coherent and emergent whole, which we name a synergistic environment.

1.1. Gesture

Our usage of the term "gesture" derives its meaning from the performance of instrumental music. The musical gesture is a functional and expressive body movement that triggers the emission of sound. It has maintained a prominent role as an imaginary and metaphorical aspect in purely electronic music, in that it allows the composer and audience to relate an acoustic perception to a performative experience. Gestures in Stocos play a very prominent role as aesthetic and expressive elements of the performance as well as an algorithmic aspect of the underlying simulations. The emphasis on musical gesture becomes visible in the gestural repertoire of the dancers and the video imagery that emphasize qualities such as energy, continuity, and rhythmicity. The biophysical notion of gesture as "… an energy-motion trajectory which excites the sounding body.." [1] renders the generation and response to gestures accessible to physics based simulations. This algorithmic approach allows us to treat natural and simulated gestures as intrinsic aspects of the generative processes that give rise to synthetic sounds and imagery

1.2. Synergistic Space

The term "synergy" refers to the cooperative activities of several components of a system, which give rise to a property or behavior that is unachievable by each component alone [2]. In Stocos, the complexity of the performance arises from the interrelated activities of the dancers, the simulation based entities, and the generative music and imagery. We employ the term "synergistic space" to emphasize the fact that the appearance and behavior within the performance space is not dominated by one individual activity but rather results from the relations and feedback mechanisms that connect all activities. It is the changing characteristics of these relationships that form the choreographic structure of the performance.

1.3. Relationships

The relationships among the activities on stage encompass both spontaneous and improvised interactions as well as pre-determined forms of synchronization. To discuss these interactions in more detail, we distinguish the following three types of relationships: algorithmic relationships deal with interdependencies on the level of the generative mechanisms that form the basis of the performance, behavioral relationships address higher levels of interaction that involve aspects of agency and autonomy among the performers, spatial relationships concern issues of blending the natural and artificial characteristics of the stage by creating spatial correspondences.

1.3.1. Algorithmic Relationship

The simulations that underly the activities on stage are based on algorithms for modelling the movements of large groups of simple entities in space, in particular, the brownian movement of microscopic particles and the coherent movement of flocking animals. These algorithms form the main generators for creating the acoustic and visual feedback in the piece and they also control aspects of the dancers' movements. Due to the fact, that most aspects of the piece are based on identical algorithms, the performance is characterized by an algorithmic consistency.

Figure 1: Rain Scene. The swarm simulation behaves similar to rain that is perturbed by gusts of wind.

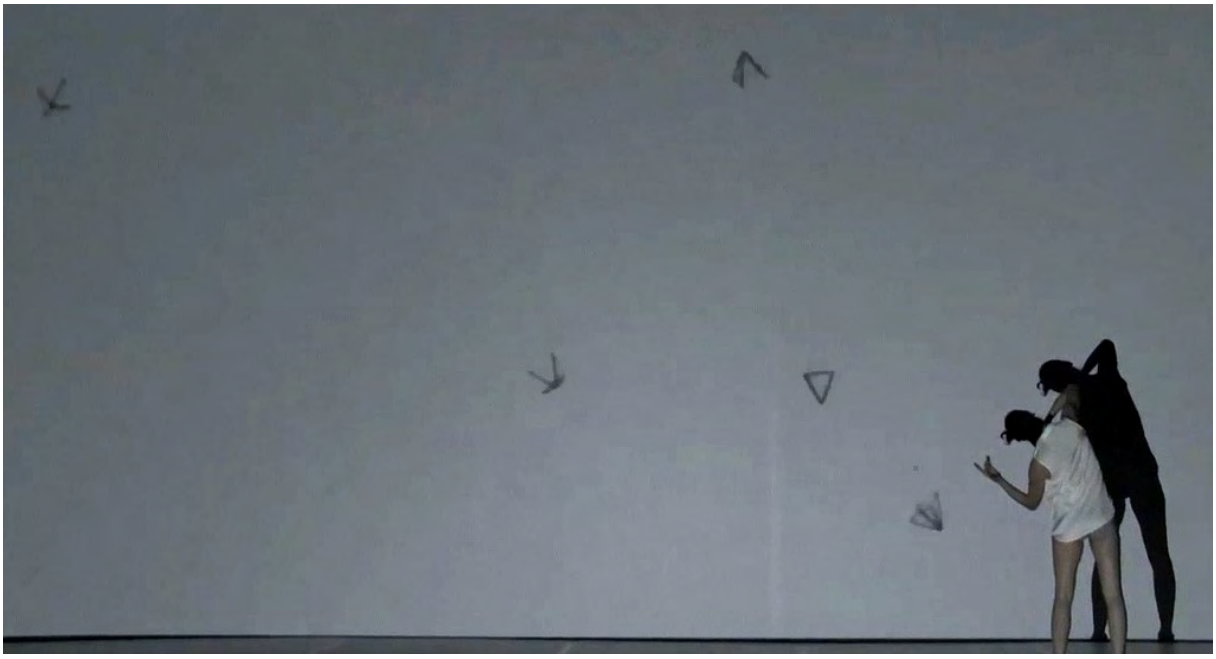

Figure 2: Five Elements Scene. A swarm that consists of five agents only engages into a improvised "duet" with a dancer.

The sound synthesis method, which is based on Dynamic Stochastic Synthesis (see section 2.5), directly creates the waveforms from the spatial movements of the simulated entities. The simulated behaviors of these entities are also executed by the human dancers, who engage during parts of the performance in synchronized activities and brownian movements. On the scale of the entire performance, pre-composed changes of the simulation parameters control both the musical and choreographic development.

1.3.2. Behavioral Relationships

The stage is inhabited both by human dancers and simulated entities, both of which possess a behavioral repertoire and the capability to perceive and respond to each other. With respect to the simulated entities, the perception based behavioral correspondence relies on computer vision software that detects the dancers' positions, contours and movements (see section 2.2) as well as simulation mechanisms that relate this tracking information to changes in the agents' number, behaviors and properties (see section 2.3). The human dancers can perceive the simulated agents via their influence on the generative creation of music and visuals. Most of the behavioral relationships throughout the performance involve spontaneous and improvised forms of interactions between dancers, swarm simulations, music and visuals. Depending on the complexity of the simulation, the agents either possess very little autonomy and behave like a physical phenomena that can be directly controlled by the dancers (see figure 1), or the agents maintain a high degree of autonomy and thereby act more akin to improvisation partners (see figure 2). Due to the simulation's influence on the generation of music and imagery, the agents also act as mediators between the dancers' physical movements and the audiovisual content of the piece. The dancers' role in the creation of the music depends on the degree of the agents' autonomy. If the agents possess very little autonomy, the dancer's bodies act as musical instruments that trigger an immediate sonification. In case of highly autonomous agents however, it is the agents themselves that act as musicians who loosely relate to the dancer's activities.

1.3.3. Spatial Relations

The appearance of the stage manifests itself via an acoustic and visual merging of physical space and simulation space. This merging is achieved by aligning the spatial characteristics of the dancers or the stage with the spatial characteristics of the simulation. The alignment includes both the spatial mapping of the video tracking based information and the spatial projection of music and imagery into the performance space. The musical composition is realized as an acoustic space that surrounds performers and audience. In addition, the stage is divided into distinct acoustic regions that allow the dancers to chose and modulate different sounds based on their position in space. The projections of the visuals are superimposed with the stage floor, the stage background and the dancers' bodies. As a projection on the entire stage, the video image creates an immersive and responsive visual environment that supersedes the visual appearance of the physical space and the dancers (see figure 3). As a stage projection within the vicinity of the dancers, the video image coalesces into clearly confined shapes that appear as visual counterparts to the dancers (see figure 4). By aligning simulation space and body space, the video image is projected solely on the dancer's body. In this situation, video imagery and the dancer's physical body merges into a single entity whose appearance possesses both natural and artificial properties (see figure 5).

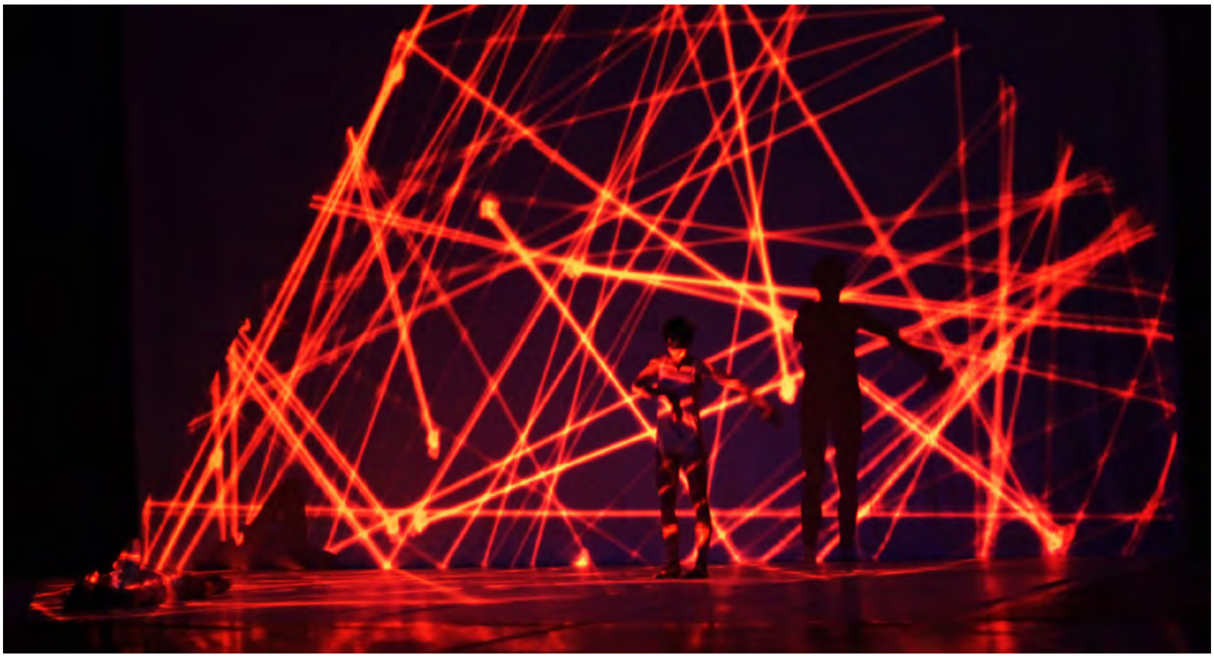

Figure 3: Plane Scene. The swarm's visualization moves within a rotating space that supercedes the physical appearance of the stage.

Figure 4: Contours Scene. The swarm creates afterimages of the dancers' body postures.

Figure 5: Blood Scene. The appearance of blood vessel like patterns on a dancer is caused by a swarm whose movement and appearance is confined to the dancer's body.

2. Realization and Implementation

Stocos has been developed throughout three residencies in 2011 as a collaborative work between the choreographer and dancer Muriel Romero and the two authors of this publication. The realization of the piece has been characterized by an iterative approach in which concept formation, technical development, audiovisual creation and choreographic experimentation continually informed each other. For instance, most of the customizations of the swarm simulations have originated from choreographic ideas of relating the dancer's movements to visual and acoustic changes that propagate through space. Fortunately, the residency situation enabled us to quickly evaluate even the most sketchy of ideas in a real stage situation. This allowed the creation of the piece to progress in a very exploratory fashion without a need to prematurely focus on preconceived decisions. It is this open minded and experimental situation that proved to be most fruitful for combining ideas from contemporary dance with generative music and art.

2.1. Stage Setup

The visual appearance of the stage is dominated by two white rectangular regions, that lie next to each other and delineate the horizontal and vertical extensions of the performance space (see figure 6). The dancers' activities and the video projection are confined to this rectangular regions. The video image is projected by two beamers that are located in front of the stage and above the stage. These beamers are aligned to match the white rectangular regions and to create a spatial continuity between the horizontal and vertical sections of the video images.

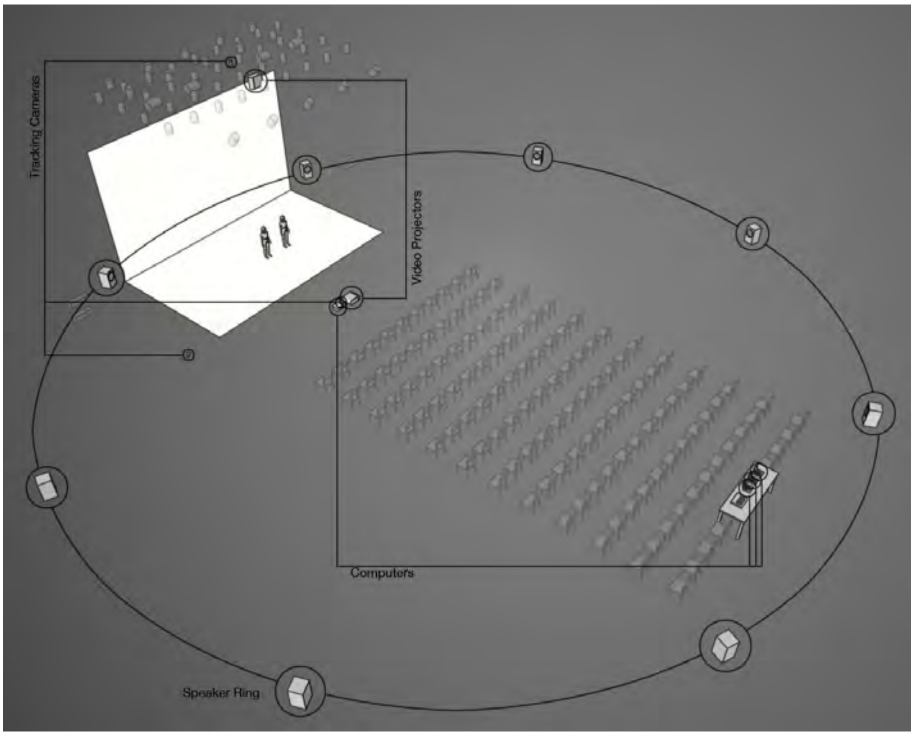

Figure 6: Stage Setup. A graphical depiction of the stage situation showing the white rectangular projection surfaces, light setup, video projectors, tracking cameras, octophonic speaker ring and computers.

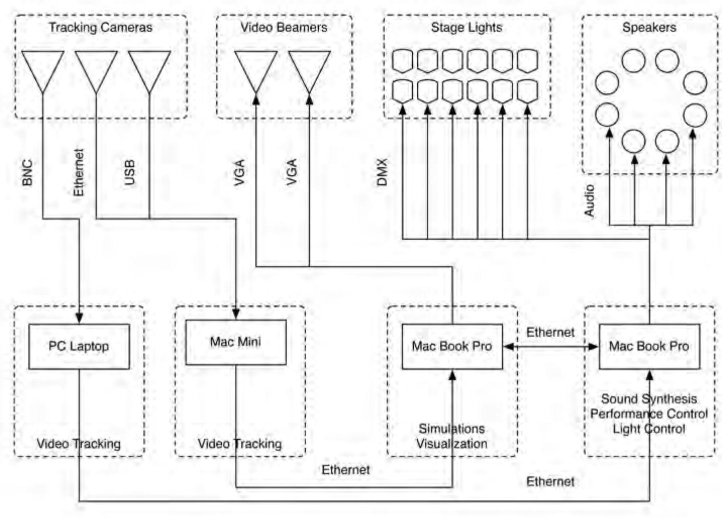

Figure 7: Communication Setup. A schematic depiction of the computers' tasks and communication with the light setup, video projectors, tracking cameras and speakers.

The audio setup consists of an octophonic speaker ring that surrounds the stage and audience space. This speaker ring provides the means to spatialize audio within a horizontal plane. The dancer's activities are tracked via three video cameras that are located on the ground in front of the stage, on the ceiling above the stage and at an elevated ground position on the front left side of the stage. The different characteristics of these cameras and their different points of view provide the means to quickly and accurately detect the dancers' positions, postures and movements on stage (see section 2.2).

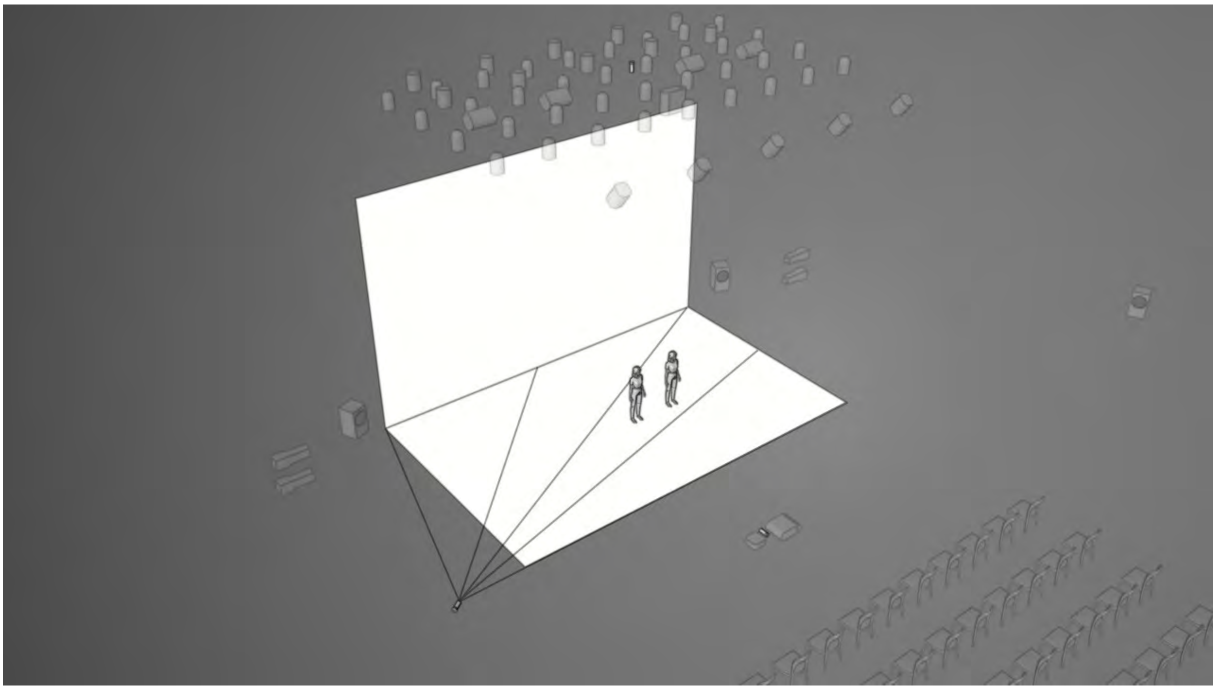

Figure 8: Tracking Regions. The stage is divided into several tracking regions that are associated to different sounds.

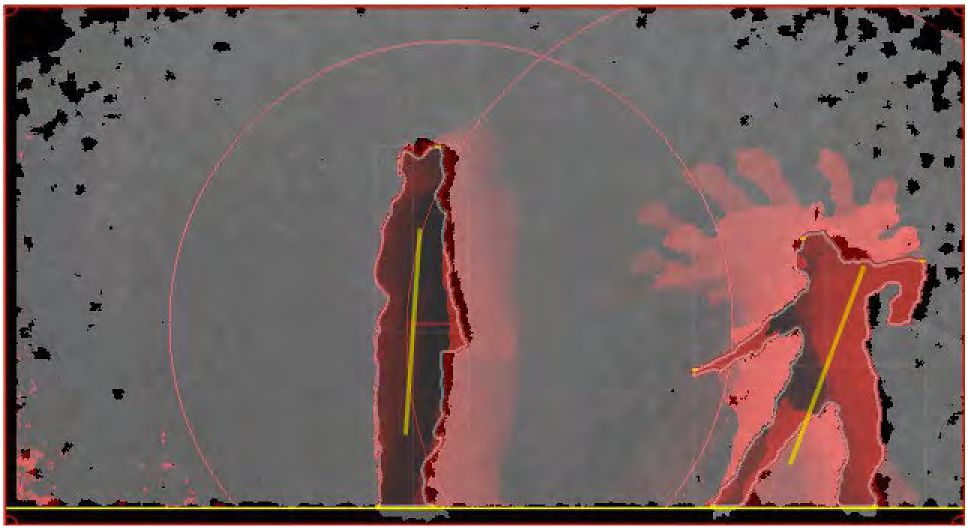

Figure 9: Tracking Software. A custom developed tracking software detects the dancers' positions (grey bounding boxes), postures (yellow direction lines), contours (grey silhouettes) and movements (red circles and gradients).

The computer-setup for the performance consists of four machines that share the computational load for handling the simulations, video tracking, image rendering, audio generation and light control. These computers synchronize their activities and exchange messages via a local network (see figure 7).

2.2. Video Tracking

Two different types of video tracking systems are employed during the performance. For those sections of the performance during which the dancer's movements directly affect the life generated synthetic sounds, an analogue video camera in conjunction with the Eyecon video tracking software and the Supercollider programming environment [3] is used to provide a low latency movement detection. In this situation, the stage is divided into distinct regions, that are associated with different sounds (see figure 8). These sounds are triggered and modulated via the dancers' movements in space (see section 2.5). This system is also used for a very immediate control of simulated agents, such as the agents' creation or destruction via discrete dance movements or the agents' freezing and unfreezing via tracking movement thresholds.

Spatially more intricate interactions between the dancers and the simulation based entities rely on a tracking software that has been custom developed in C++ by one of the authors and that provides more extensive albeit slower tracking information about the dancers' positions, postures, contours and movements (see figure 9). This software acquires a video image from a ceiling mounted digital camera and a distance image by a Kinect camera that is located in front of the stage. The tracking data is sent to the simulation software. Tracked movement and position information controls the creation, location and speed of simulated agents that are hidden to the audience but that can be perceived by the other agents. Tracked contour information serves to manipulate spatial structures within the simulation space. Many of the swarms' behaviors that have been specifically developed for the performance deal with perceiving and responding to these tracking based spatial structures.

2.3. Simulation

The computer simulations that have been developed by the authors for this piece model the movements of large groups of simple entities in space, in particular, the brownian movement of microscopic particles and the coherent movement of flocking animals. The implementation of these simulations is based on a C++ simulation library that has been developed by one of the authors as part of a research project about swarm based music and art [4][5]. One of the main benefits of this simulation library is its ability to enable the creation of highly customized swarm simulations that can be extended and modified during runtime. These simulations can easily interact with other software due to their OSC based control and communication mechanisms.

In the case of Stocos, the behavior and visualization of the simulations change fundamentally throughout the piece. These changes are synchronized with the musical composition via OSC commands that are sent from a Supercollider based program to the simulation and visualization software. Several agent behaviors have been specifically designed for this piece. Most of the new behaviors deal with the capability of the agents to respond to the presence of the dancers. Agent creation and destruction behaviors serve to change the number of simulated agents depending on the dancer's movements. In most cases, no movement causes the destruction of agents whereas large movement triggers the creation of agents. Other behaviors cause the agents to experience forces of attraction and repulsion in relation to the dancers' body contours. The creation of tangential forces causes agents to follow the body contours. Attraction forces pull agents towards particular features of the body contours such as the tip of the head or the center of the fastest moving body part.

The simulations that have been created for the performance differ with respect to the number of swarms and the number and type of agent behaviors. Simulations that implement only tracking based behaviors are highly responsive and predictable. They therefore tend to resemble physical phenomena that can be directly manipulated by the dancers. At the other extreme are simulation that combine tracking based behaviors with typical swarm behaviors that control interactions among the agents themselves. These simulations exhibit a much higher degree of behavioral diversity and complexity and their response to the dancers is less predictable. In this case, the simulated agents participate in the performance as autonomous artificial dancers.

2.4. Visual Rendering

The visualization of the swarm simulations is implemented in C++ and employs fairly simple OpenGL based rendering. Throughout all the renderings, the agents themselves are either hidden or depicted as small solid bodies such as spheres or pyramids whose orientation is derived from the velocity of the agents. Agent trajectories are visualized as trails by drawing line segments that sequentially connect previous agent positions. Some visual diversity is achieved by rendering to multiple textures, which are then modified via image post-processing and finally blended together. Most of the visual diversity results from the influence of the agent behaviors on the spatial distribution and dynamics of the agent trails. This emphasis on agent behavior as a main source of visual diversity represents a gestural approach to visualization that draws inspiration from the role of musical gestures in shaping an acoustic result. In order to preserve the continuity of the simulation space when projecting the visualization onto the vertical and horizontal surfaces of the stage, the final rendering is split into two partial images that can be independently aligned for the two video projectors. To further control the overlapping of the projected video image with the stage setup and the dancers, the tracked contours of the dancers are used to create grayscale images. These images serve as alpha channels that fully or partially mask those parts of the projected video image that lie outside of the dancers' bodies. To achieve an accurate alignment of these masks with the dancers' physical positions, the offset and scaling of the mapping from tracking space to visualization space is calibrated at different depths of the stage.

2.5. Sound Synthesis and Music

The music of the piece combines life generated and precomposed acoustic material. This material is synthetically generated via a method of sound synthesis entitled Dynamic Stochastic Synthesis. This method has initially been devised by Iannis Xenakis [6][7] and employs simulated brownian movements as a stochastic mechanism to modify individual digital samples and thereby directly manipulate the sound pressure curve of an audio waveform. According to this method, the waveform is polygonized via a number of breakpoints (see figure 10). Each of these breakpoints is constantly perturbed by two random walks that control the amplitude and duration of the waveform. The values generated by the random walks are delimited by so called mirror barriers.

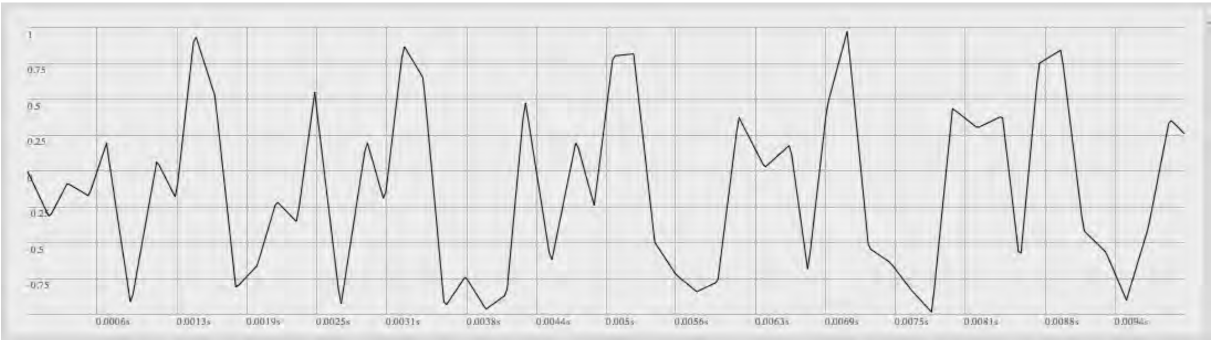

Figure 10: Dynamic Stochastic Synthesis. Time domain plot of a waveform's that has been created via Dynamic Stochastic Synthesis.

For Stocos, the method of Dynamic Stochastic Synthesis has been implemented in the Supercollider programming environment by one of the authors. The implementation was necessary because the unit generators that implement this method of sound synthesis and that form part of the standard Supercollider environment suffer from several simplifications that limit their flexibility. Our implementation of Dynamic Stochastic Synthesis has been specifically customized and extended for the performance.

On an algorithmic level, the constraints on the simulated brownian movements that give rise to the synthesized sounds are modified by the activity of the simulated agents. Each agent is coupled to one stochastic synthesizer via a variety of relationships. One relationship maps an agent's vertical position to the position of the synthesis mirror barriers. Another relationship employs the similarity among the agents' velocities to control the step size of the synthesis random walks. A third relationship connects the spatial trajectories of the agents to the spatialization of the synthesized sounds via the octophonic speaker ring.

Another extension of the Dynamic Stochastic Synthesis model that has been created for Stocos allows the dancers to interactively control the synthesis algorithm. As a result, the process of sound synthesis and the spatial projection of the resulting sounds is tightly intertwined with the dancers' activities.

Finally, the compositional structure of the music is generated via temporal patterns that also affect the properties and visual rendering of the swarm simulation. This creates a feedback loop that in turn affects the stochastic synthesis.

2.5. Dance

The dancers' activities form an integral part within the network of relationships that underly the generative creation of music and imagery. The simulation based approach in the piece is reflected in the development of their movements. During highly formalized sections of the choreography, the dancers organize their spatial movements and gestural patterns strictly according to algorithmic rules that are derived from the simulation of brownian movement. These random walks are used by the dancers to "walk" among the different parts that comprise previously composed dance variations and thereby give rise to reverberations of the original choreographic structure. Both of the dancers employ different random walks, which results in two quasi similar movement patterns. The algorithmic procedures that are followed by the dancers have been created in Supercollider.

For their improvised movements, the dancers heavily relate to the behaviors of the simulated entities that manifest themselves in the changing acoustic and visual properties of the stage. Depending on the characteristics of the simulation, dancers and simulated entities relate to each other differently. Simulations that mimic the behavior of physical phenomena respond very directly and predictably to the activities of the dancers. These simulations allow the dancers to amplify the spatial extension, duration and intensity of their movements. Those simulations that model highly autonomous agents respond to the dancers activities in less predictable ways. In these situations, the human dancers relate to the agents as artificial dancers. Depending on the quickness and strength with which the simulation responds to the human dancers, these artificial dancers act as improvisation partners or independent soloists.

The dancers' presence and activities play an important role for the creation of the music. Throughout most of the piece, it is via the dancers influence on the behavior of the swarm simulation that they indirectly affect the creation of the music. In this situation, the dancers' musical role resembles that of a conductor, who tries to control a more or less compliant orchestra. During other sections of the performance, the swarm simulation cedes control of the music entirely to the dancers. In these situations, the dancers' gestures are directly linked to sound synthesis. The dancer's bodies become musical instruments and their gestures become musical gestures. In combination with the segmentation of the stage into different acoustic regions, the dancers' movements through space change the characteristics of their "instrument" bodies and thereby reveal new acoustic qualities of their gestures.

2.6. Choreography and Composition

Due to the synergistic characteristics of the performance, it is the interrelationships and feedback loops between dancers, swarm simulations, music and imagery that shape most of the choreographic content of the piece. The dramaturgy of the performance, on the other hand, follows a pre-determined structure that is tightly associated with the musical composition of the piece. The progression of the composition not only controls the music but also modifies the properties of the simulation and its visualization. Accordingly, the algorithmic, behavioral and spatial relationships of the synergistic space undergo a precisely timed progression of changes and therefore are part of the global compositional structure of the performance.

3. Conclusions

The realization of Stocos was motivated by our curiosity whether ideas from algorithmic composition and generative art can be transferred to contemporary dance and vice versa. In particular, we were hoping that by sharing and interrelating the same generative processes among dance, music and imagery, the piece would exhibit a high degree of aesthetic coherence and dynamic synchronicity rather than drift apart into individual parts that compete for the audience's attention. The notion of musical gesture that played a central role in the previous two pieces provided a very fruitful context for the creation of the current work. The phenomena of a moving body whose energy trajectory triggers and modifies perceivable phenomena is very well suited to link algorithmic abstractions with a performative experience that is very familiar to both the dancers and the audience. The decision to employ simulations of brownian motion and swarm behavior is based on this gestural focus of the piece.

The extended period of time that all the participants could work together turned out to be extremely important for the development of the piece. Due to the trans-disciplinary and experimental setup of this collaboration, an explorative and non-sequential approach to the development and evaluation of conceptual, aesthetic and technical ideas was essential to discover the potentials and pitfalls of the approach. Some of these pitfalls are common to all combinations of improvisation and technical development, in that the practicability to quickly experiment with new ideas are very different between the participants. Another challenge concerns the possibility and necessity to preserve felicitous surprises that occasionally turn up during collective experimentation. Especially when finalizing a piece, creativity can suffer from the fact that most of the work tends to get consumed in these preservation efforts. In the final version of the piece, almost all of the pre-determined changes in the global development of the performance have originated from such preserved lucky coincidences. These preservations certainly play an important role in maintaining a well planned dramatic development and in providing the dancers with reliable cues that guide them through the performance. On the other hand, they cause the work to fall somewhat short of the possibly utopian goal to create an entirely improvised and generative performance.

At the current stage, we are in the early planning phase for a new dance performance that again tries to combine dance improvisation with a simulation based approach to the generative creation of music and imagery. Since we intend to move away from the previous gestural focus and try to employ entirely different types of simulations and relationships, it remains to be seen, if we manage to create a similarly plausible coherence on both the algorithmic and experiential level. But regardless of the outcome, we are convinced that contemporary dance and generative art are promising allies in the search for new forms of audiovisual performances.

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Derya Gulec Ozer

Paper : **OPTIMIZATION OF USER ACCESSIBILITY USING GENETIC ALGORITM: ADA**

Topic: Architecture

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Abstract:
One of the most important criteria for spatial accessibility[1] is the complement of the movement in a shortest distance in a certain amount of time. However the shortest distance is a relative definition. In order to define the shortest distance in multi user spaces, optimization is necessary.

The aim of this study is the optimization[2] of user accessibility in architectural design field using a genetic algorithm[3]. In order to achieve this scope, a methodology called ADA (Algoritmic Distance Based Accessibility) is developed. This model will be introduced based on user movements and the spatial accessibility. Depending on movement analysis of different user types, relationship matrix will be created by optimization of movements on distance and time which is the basic data source for the design model to be developed. The developed plug-in, will generate optimum plan scheme based on spatial use data of users, evaluate fitness analysis of given plan scheme, and will be developed as a script to run on Rhino Grasshopper. In this methodology the process takes place in four steps:
(1) Obtaining user data: Definition of user types and their daily routes,
(2) Obtaining spatial data: Definition of main spaces, sub spaces and relationship parameters, user density, publicness/ security/ emergency levels, and evaluation of spatial accessibility parameters,
(3) Coding and optimization: Coding of flow charts in C# language, and optimization of the routes using a genetic algorithm in Rhino Grasshopper plug-in,
(4) Evaluation: Evaluation on predesigned projects, test of the model.

As for the results, the targeted outputs are as follows:
-To define spatial accessibility and determination of interdisciplinary relationship between design field and other fields (social, economic, cognitive)
-To state the contribution of user accessibility optimization model to architectural design field.
-To take into account of user movements, to develop the design model to use in preliminary design phase of large scale architectural designs such as campuses.
-To develop a model to evaluate predesigned or built architectural projects based on user movements.
-To evaluate the contribution of genetic algorithm as an optimization tool to architectural design field.

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Keywords:
User accessibility, architectural space, genetic algorithm, optimization, ADA

Optimization of User Accessibility Using Genetic Algoritm: a*DA*

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Abstract

The aim of this study is the optimization of user accessibility in architectural design field using genetic algorithm. In order to achieve this scope, a methodology called **a*DA*** *(Algoritmic Distance Based Accessibility)* is developed. This model will be introduced by analyzing movements of different user types depending on spatial and user accessibility. Depending on movement analysis of different user types, a relationship matrix will be created by optimization of movements by means of travel cost in meters which is the basic data source for the design model to be developed. In this methodology the process takes place in four steps: (1) Obtaining user data, (2) Obtaining spatial data, (3) Coding and optimization, and (4) Evaluation. The developed plug-in run as a script on Rhino Grasshopper, evaluate fitness values of given plan scheme and generate optimum plan scheme based on user data.

Concerning the results, the advantages of the design data gathered by the optimization of user routes are accentuated. For future suggestions, it is indicated that within the computational design paradigm, the human factor should be taken into consideration along with the movement models, and its contribution to design knowledge. Besides it is emphasized that the movement optimization model could be efficient to use for the design of complex buildings such as hospitals since the method will be further enriched by testing the model on such building typologies.

1. Introduction

Accessibility has received considerable interest in society in recent years, not only a luxury response reserved for special communities [1] such as disabled people, but also an oppourtunity for all. The reason to support this rationale is more functional use of buildings, therefore “design for all” concept can be practiced widely in different building typologies.

Accessibility in architecture means more than spaces that can be used for all people equally [2]. Spatial accessibility, more than in and out relations of the space, is the concept which allows the user to understand function, organization and spatial relationships and welcome them to participate in activities [3]. Better understand the concept; data, communication, movement and facilities of the user should be well defined [2]. Therefore, concerning user and spatial accessibility in the buildings, one of the most important aspect is the movement of people to consider in the design methodology.

If there is an accessible path but it takes 10 times more time [1] to reach the destination, can this be considered accessible enough? Probably not. Therefore, one of the most important criterion for spatial accessibility is the complement of the movement in a shortest distance in a certain amount of time. However the shortest distance is a relative definition. In order to define the shortest distance in multi user spaces, optimization is necessary. In this sense to concentrate on this optimization problem, evolutionary algoritms are chosed to use in the method, since this approach is a generative testing tool[4] that fits the procedure of synthesis and evaluation in the design process.

Genetic Algorithms (GAs) is very well known evolutionary algorithms, which is widely used in design process. They are used as stochastic methods for solving optimization and search problems [5], and recent work has shown their simple but powerful search capability [6]. Genetic evolutionary design concepts have been applied in the design and architecture areas and had shown promising results [7,8,9,10,11,12,13]

Therefore, a study has been conducted in this perspective, to optimize user accessibility in terms of distance, in architectural design field using genetic algorithm. In order to achieve this scope, a methodology called a*DA (Algoritmic Distance Based Accessibility)* is developed. This model will be introduced by analyzing movements of different user types depending on spatial accessibility. Depending on movement analysis of different user types, a relationship matrix will be created by optimization of movements by means of travel cost in meters, which is the basic data source for the design model to be developed.

This study is divided in three main parts. The first part examines spatial accessiblity in terms of user movements and compares the studies in the literature. The second part examines genetic algoritms in architectural design field and optimization problems. Finally the third part explains the developed method, aDA, its background studies, data collection, process and results. Moreover the third part promotes a prospective use of the method in such complex building typologies, which will be further studied.

2. Analysis of Spatial Accessibility in Terms of User Movements

Even accessibility is challenging even for healthy people; abled/disabled and healthy/unhealthy people should be considered in terms of accessibility to every space. Communal space should be accessible not only to disabled but also to everyone [14]. Therefore, “accessibility for all” motto should be reconsidered in terms of architectural design.

To better define accessibility for all concept, It will be helpful to present the spatial acsessibility components and measures. Since buildings are service providers, their quality should be measured by defining a set of representative service paths [1]. Therefore it will be useful to analyze an existing methodology to measure spatial accessibility. There are 5 criteria which can be mentioned here: Counting, total sums of distance, closest activity, gross interaction potential, probabilistic choices (Table 1).

Table 1. Accessibility Measures [1,15]

Criterion	Definition	Accesibility Measure
Counting	Counting Accessible Locations for an activity	Accessibility increases directly proportional
Total Sums of Distance	Total distance to go	Accessibility increases inversely proportional
Closest activity	The situation of the closest activity being available	Accessibility increases inversely proportional
Gross interaction potential	Attractiveness, convenience and different number of activities	Accessibility increases directly proportional
Probabilistic choices	Among the activity potentials, the probabilistic choice	Accessibility increases directly proportional

Considering spatial accessibility, there have been previous studies [2,14,16,17,18,19,20,21]. Among these works, internal and external accessibility is defined and studied [16], horizontal and vertical circulation within the building is considered internal, relationship with the nearby environment and the town is considered to be external [17]. Studies considering internal accessibility focuses on accessible design criteria [21], theoretical and practical knowledge integration [2] and use of physical environmental data [19], orientation and user types [18] in hospitals. On the other hand studies considering external accessibility focuses on setting criteria in mass housing [14] and layout pattern evaluation [20]. As far as this paper focuses on internal accessibility measures and user movements, it is important to point out that accessibility should be considered in various parameters, but it is important to define proper evaluation criteria for the desired solution.

2.1 Developed methods for space planning and accessibility in the literature

There are many methods focusing on the place of accessibility concept in design, its development and generation. The ones we consider here are space layout planning, space syntax and wayfinding to overview.

Space layout planning is the assignment of discrete space elements to their corresponding locations while having relationships with each other [6]. The relationships include topology and geometry where topology implies using grammars and geometry implies mathematical programming or related optimization techniques [6]. There has been many researches on this issue [6,22,23,24,25,26] focusing on constructive placements, synthesizing layouts using generative grammers and use of genetic algorithms in topographical and geometrical problems. The planning problem points out three important aspects; how to formulate the problem, how to control the generated solutions and how to evaluate depending on various criteria [6].

The studies that focused on architectural planning order can be summarized as; the placement of rectangular units on a plan [27], planimetric parameter optimization [28], use of genetic algorithms with the method of activity grouping [29] and use of knowledge based systems in antropometric data base optimization [10]. In larger scale projects, a heuristical approach of ant colony optimization is used for relating activities and spaces in an office block [30]. The common result to be realized from these studies is to generate solutions based on specific parameters meeting fitness function requirements in architectural planning scale.

Another method to overview is space syntax, which is a research program to define the relationship between people and space within general theory perspective of building/ settlement/ city structure. The startup of the concept is the people using space as a key to organize for themselves [31].

There are many researches on interior space analysis, some of them are; comparison of two distinct office spaces (designed and built) via axial mapping [32], characterization of a space as a whole with graph spectra and plan generation via optimization with genetic algorithm [33] and an evacuation system proposal stressing spatial, ergonomical and cognitive parameters [34]. In this respect, additionally there are studies defining and practicing accessibility measures due to distance and time [35]. The common point of these studies is the feasibility of space analysis due to physical and sociological measures and the use of computational methods in space syntax methodology.

The studies doing compative studies concentrating on human movement are useful to inspire this research. One exemplar study make a comparative study of real and virtual environments and show the results of human movement to influence the spaces [36]. Whereas another one studies a virtual environment via wayfinding and compares the movement and cognition data [37]. The results shows us whether in a real or virtual environment, human movement is a key factor to affect the design methodology.

The final method to overview and compare within the literature is wayfinding. Being a concept relating environmental and behavioral studies, wayfinding is defined as the action to start from a departure to reach a target [38]. A successful wayfinding is a behaviour to know the location and best route, to follow, to recognize the target and to find the way back [39].

The studies regarding wayfinding are; evaluation of wayfinding concepts on the distance, user route and actions with observing human behaviours [39], wayfinding analysis of the users of before and after use of space [40], the factors to effect wayfinding behaviour, its impact on building configuration, visual accessibility, circulation systems and signs [41].

The above mentioned methods have shown us, there are multifold driving forces for an enhanced building accessibility. Among these forces, user data is important regarding the matching of the generative process to the architectural design process. In the following section we focused on genetic algorithms in architectural design field and optimization.

3. Genetic Algoritms in Architectural Design Field and Optimization

Genetic Algorithms, inspried by genetics, is a stochastic method for solving optimization and search problems, operating on a population of possible solutions [5], based on natural selection criteria. The process is based on probability rules with use of fitness function to search the related solution space [42], in a relatively shorter time [43].

As mentioned before, one of the most important criterion for spatial accessibility is the complement of the movement in a shortest distance in a certain amount of time. Since the shortest distance is a relative definition, optimization is necessary to define the solution. Searching for previous optimization problems, the example of a system of lineer inequalities can be taken as a good example for this paper's methodoogy. Among many possibilities of a movement route starts with a point and ends with a destination point, the problem is the total distance optimization (Figure 1).

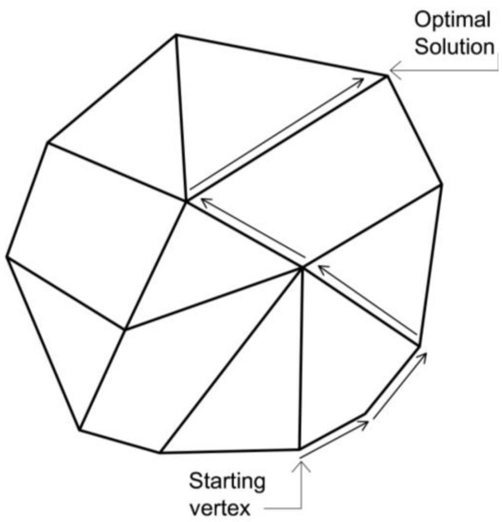

Figure 1. A system of lineer inequalities: It begins at a starting vertex and moves along the edges of the polytope until it reaches the vertex of the optimum solution[44]

Genetic algorithms are an appropriate form of communication [6] between the architectural design and genetic evolutionary processes. The studies in this the field of space layout problem solving and optimization can be summarized as; genetic optimization techniques used in space layout problems [6] and geometrical space planning via dimensioning of space elements [45,46,47,48]

The studies regarding architectural space can be pointed as; use of nature inspried genetic/evolutionary design model on space planning [6], a knowledge based system proposal on an optimal office layout [10], generation of space layout typologies for architectural plans with an evolutionary approach [11], use of genetic algorithms in space layout planning [29].

Since genetic algorithms are proposed to be the best tool to use in optimization problems in architecture field, it is used in the method we developed in the following section.

4. Algoritmic Distance Based Accessibility Model (ADA)

The aim of the developed method is to analyze user movements in the building environment in terms of accessibility and optimize the user routes due to accessibility criteria using genetic algorithm. Depending on the literature discussed before, the main problem in this work is optimization of user and spatial accessibility using distance data using genetic algorithm and transforming the data obtained into a design methodology.

In this methodology the process takes place in three steps (Figure 2):

(1) Obtaining user data: Definition of user types and their daily routes,

(2) Obtaining spatial data: Definition of main spaces, sub spaces and relationship parameters, user density, publicness/ security/ emergency levels, and evaluation of spatial accessibility parameters,

(3) Coding and optimization: Coding of flow charts in C# language, and optimization of the routes using a genetic algorithm in Rhino Grasshopper plug-in.

Depending on movement analysis of different user types, relationship matrix will be created by optimization of movements on distance and time. This matrix will be the basic data source for the design model to be developed. The procedure followed is the examination of user movements and development of their schemes in the flowchats (Figure 3) and drawing of the user speed/distance table (Table 2).

Table 2. User Types and Speed/Distance Table

		Healthy								Unhealthy							
		Disabled	Speed(m/h)	Min. distance(m)	Max. distance	Normal	Speed(m/h)	Min. distance(m)	Max. distance	Disabled	Speed(m/h)	Min. distance(m)	Max. distance (m)	Normal	Speed(m/h)	Min. distance(m)	Max. distance (m)
User A	Type1	o	300	3	75*												
	Type2					o	500	3	125*								
User B	Type3									o	200	3	33,3**				
	Type4													o	400	3	66,6**
		* For a healthy user, maximum walking time between two locations is accepted as 15 min.								* *For an unhealthy user, maximum walking time between two locations is accepted as 10 min.							

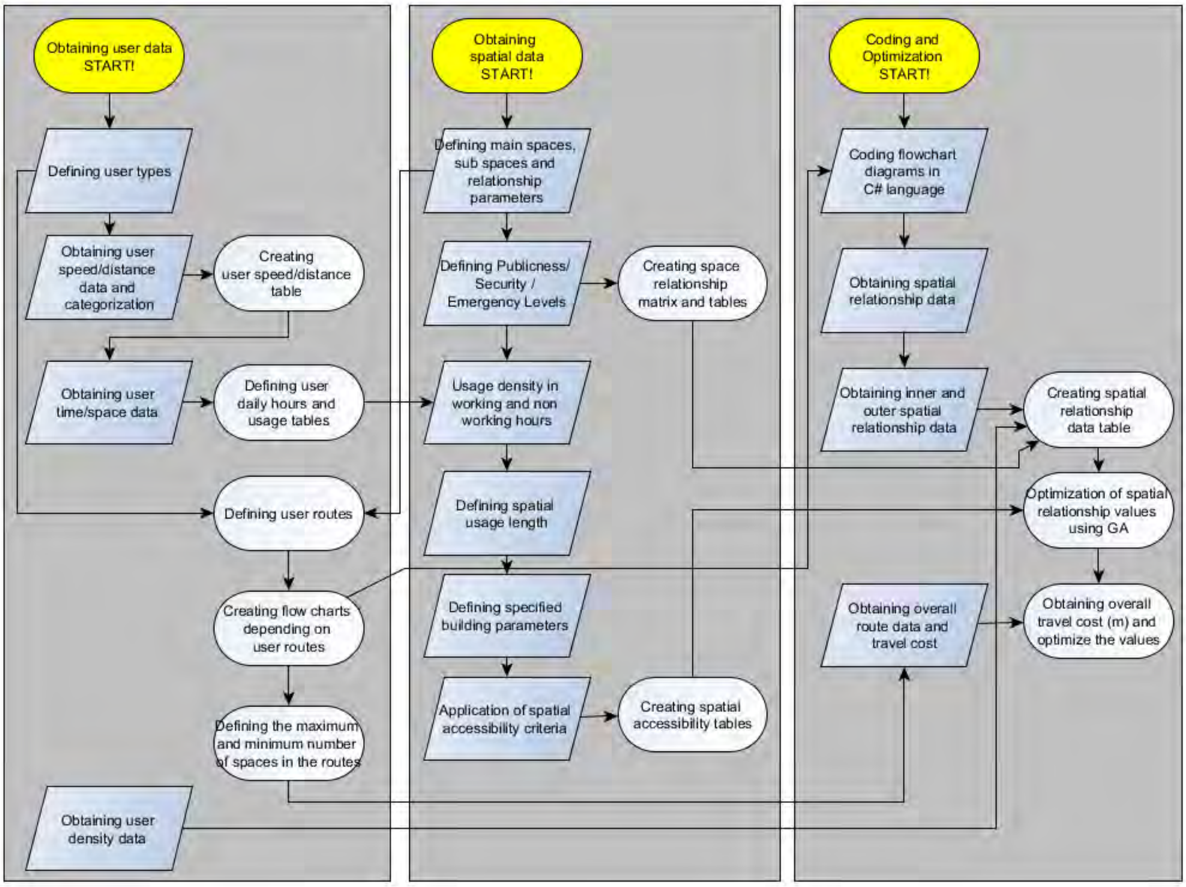

Figure 2. The Method Chart

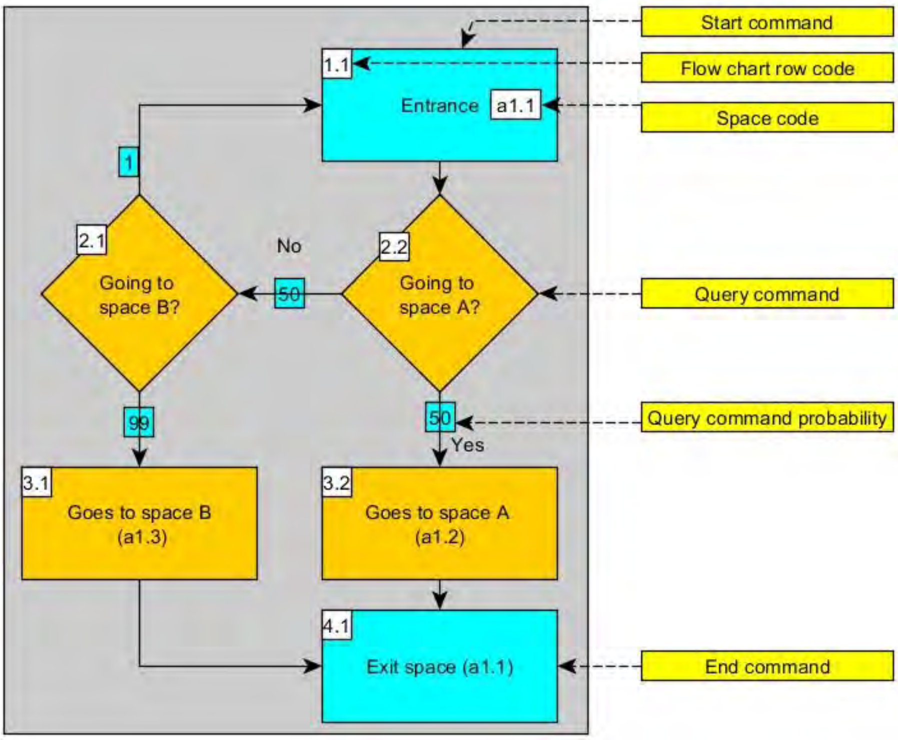

Figure 3: An example of a flowchart of a user route

Using these data sets, a simple genetic algorithm is designed with a special fitness function. Two components are generated in Rhino Grasshopper interface (Figure 4); *User Component* is used to process user movement data. The user component takes an xml file that includes node data and generates paths (Table 2). *Genetic Solver Component* is used to optimize the routes. It takes the user paths and relations and creates the coordinates for spaces using a genetic algorithm (Table 3).

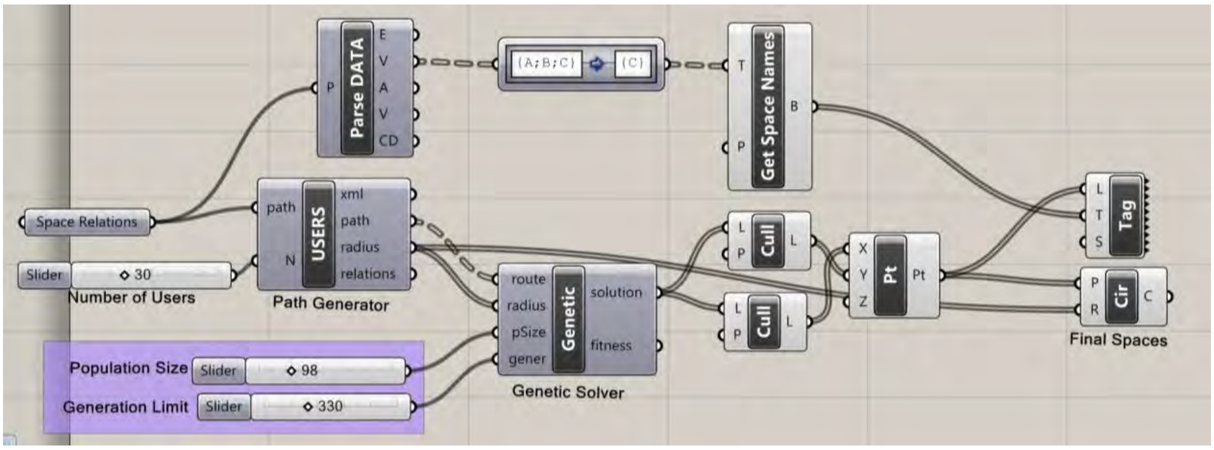

Figure 4. Rhino Grasshopper interface

Table 3. User Component

INPUT	*Type*	
XmlDocument	File	The xml file
Int	Number of users	The number of user paths to be generated
OUTPUT	*Type*	
DataTree<int>	Path	Generated paths according to probability schema
DataTree<int>	Relations	Relation degrees between spaces
String[ ] names	Nodes	Name of the nodes in paths.
Double[ ] radius:	Degree	Usage degrees of spaces.

Table 4. Genetic Solver Component

INPUT	*Type*	
DataTree<int>	Path	Generated paths according to probability schema
DataTree<int>	Relations	Relation degrees between spaces
Int populationSize	Population	Population Size of genetic algorithm
Int generations	Generation	The number of generations as termination criteria
OUTPUT	*Type*	
Double[ ] solution	Coordinate	Coordinates of spaces
Double fitness	Fitness	Fitness value of the solution

The Genetic Algorithm parameter selection criteria are the chromosome, addition mutation, multiplication mutation, crossover, fitness function and selection. *Chromosome* is defined by a array of doubles that represent x and y values of points. x and y values are stored consequently for each point. (x value =

chromosome[n] , y value = chromosome [n+1]). There is two types of mutation defined for this chromosome.

Addition Mutation is change of x and y values in a range. In this case the range domain is defined as (-20,20). When this number increased diversity increases in the population, and decreases in reverse. Convergence to optimum solution slows down in too high or too low values.

Multiplication mutation, multiplies x and y values in a chromosome with a number within the range (-5,5). Similar to addition mutation, different values effect the diversity and convergence.

Crossover is a single point crossover used in this algoritm.

Fitness Function is defined as a special one for this algorithm. The fitness function takes two consequent points in the chromosome and calculates distance. Then it subtracts the relation degrees between those points. This function repeats until the end of the chromosome. Finally, the fitness value is determined as 1 divided by the result (1).

$$result = \sum_{i=1}^{n} \sqrt{(x_i - x_{2i-1})^2 + (y_i - y_{2i-1})^2} \quad (1)$$
$$fitness = 1/(result - relationDegree)$$

Selection is defined as elite selection method for this algorithm.

The objective of the algorithm is to maximize the fitness function through generations. Our findings show that the algorithm successfully increases the fitness value, however most of the times there is no “perfect solution” thus it gives an approximation resulting with fitness values lower then 1 (Figure 5). Since the fitness function tries to make the results closer to relation degrees, end product is ideally a set of tangent circles, where every circle representing a space and the radius of it is the degree of usage (Figure 6). Genetic algorithm runs with specified population size until the specified generation. After the algorithm terminates, the genetic solver component writes the coordinate values as output. These values can be used to create spaces.

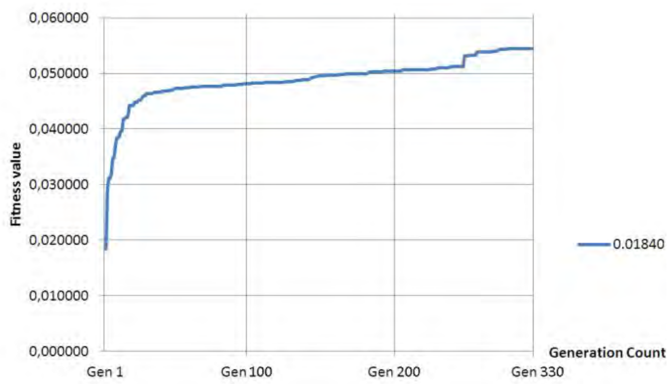

Figure 5. Fitness values and generations

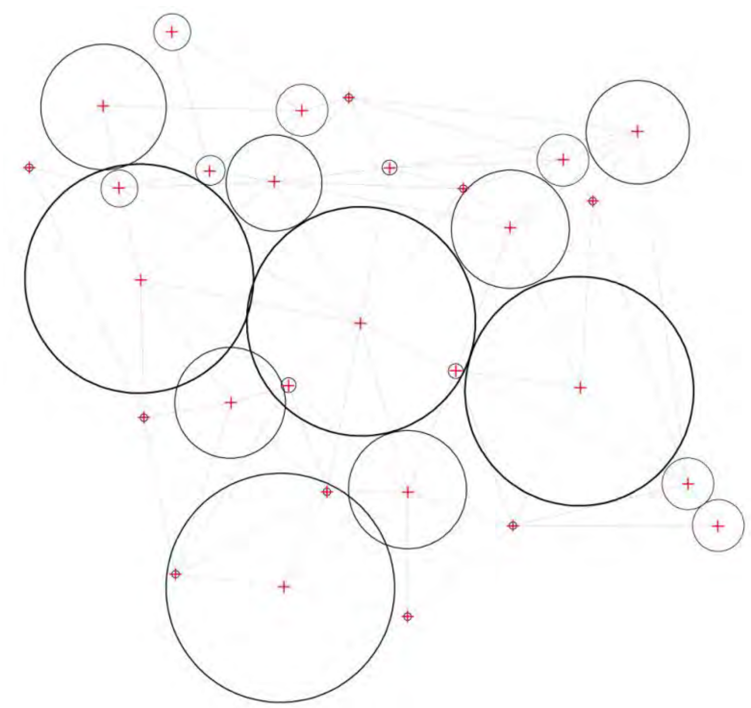

Figure 6. Final solution after 330 generations

5. Results and Prospective Studies

We used user movement diagrams and aimed to generate new planimetric possibilities towards an optimized behavior of the final configuration in site plan scale. We developed a script based tool that works as a component running in Rhino Grasshopper. This work focuses mostly on those aspects related to the user movement inside spaces.

As for the results, the targeted outputs are as follows:

-To define spatial accessibility and determination of interdisciplinary relationship between design field and other fields (social, economic, cognitive)

-To state the contribution of user accessibility optimization model to architectural design field.

-To take into account of user movements, to develop the design model to use in preliminary design phase of large scale architectural designs such as campuses.

-To develop a model to evaluate predesigned or built architectural projects based on user movements.

-To evaluate the contribution of genetic algorithm as an optimization tool to architectural design field.

The capability of producing optimized solutions and effective use of computational techniques for the given set of user data proves the utility of the developed model.

The utility of the model will be further studied and compared in complex building typologies such as hospital campuses.

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Dmitry Weise

Paper: **PHYLLOTAXIS OF THE VATICAN PIGNA**

Abstract:
In the Giardino della Pigna in the Vatican there is a giant pinecone (la pigna). The Pigna was modeled and cast during the first or second century CE.
Decorative pinecones are often used as an ornamental element. But in most cases anatomy of ornamental pinecones is different from the anatomy of the vegetative ones. Artificial pinecones are too much artificial. But the pinecone in courtyard of Vatican looks like a living thing!
In botany, phyllotaxis is the arrangement of leaves on a plant stem (from Ancient Greek *phýllon* "leaf" and *táxis* "arrangement"), as well as a mathematical discipline that went beyond studying only plants. In the arrangement of leaves on different plants one can see interesting general mathematical consistent pattern. The study of phyllotaxis has its own history. The large scientific experience was accumulated, the methodologies and the terminology were developed.
The Pigna in the courtyard of Vatican is described in mathematical terms of phyllotaxis and symmetry.

Topic: Design Approach

International Society for the Interdisciplinary Study of Symmetry (ISIS)
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The Pigna in the courtyard of Vatican

References:
[1] Roger V. Jean, "*Phyllotaxis: A Systematic Study in Plant Morphogenesis*", New York: Cambridge University Press, 1994

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Keyword: Phyllotaxis

Phyllotaxis of the Vatican Pigna

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Premise

In 2011 I had the honor to be invited by Mr. Soddu to the *XIV Generative Art International Conference*. Needless to say the interest of the conference itself and the interest to visit the Eternal City for the Russian, who had never visited Italy - homeland of Leonardo Pisano and Leonardo da Vinci (chronologically). For me, the interest was to find an answer to the question, troubled me long time. Once in the television show I saw a giant pinecone, located in the Giardino della Pigna in the Vatican. I was struck by the statue naturalism.
In my work the Pigna in the courtyard of Vatican is considered from the point of view of symmetry phyllotaxis and symmetry.

1. Decorative pinecones and Phyllotaxis

Decorative pinecones are often used as an ornamental element. But anatomy of ornamental pinecones in most cases is different from the anatomy of the vegetative ones. Artificial pinecones are too much artificial. But pinecone in courtyard of Vatican looks like a living thing! “Perché non parli?”

Picture 1. Perché non parli? - Why are you silent?

Let's give some preliminary explanation.

1.1 Phyllotaxis

Phyllotaxis: from Ancient Greek *phýllon* "leaf" and *taxis* "arrangement"). Phyllotaxis is the arrangement of the leaves. Many plants with spiral leaf arrangement forming elements (leaf scales, spines, seeds, etc.) are arranged in rows distinguishable to the eye. The eye tends to connect nearest points into spirals. These spirals are called *parastichies*. Usually there are two sets of parastichies winding in different directions. On the shoots of plants contact parastichies numbers are, typically, the Fibonacci numbers. The name given in honor of Leonardo Pisano, who in 1202 published the famous *Liber abaci*. This book was first introduced a sequence of 1, 1, 2, 3, 5, ..., where each successive number is equal to the sum of the previous two. On very rare instances of plants (not taxonomic species) one can meet other series, such as 1,3,4,7,11 ... - Lucas numbers. Another example is 2, 2, 4, 6, 10..., where the numbers have a common factor greater than 1, in this case 2. Such phyllotaxis called *multijugate*. In either case, the series constructed by the rule of the Fibonacci - each subsequent equals to the sum of the two previous ones, as mentioned above.
Rising phyllotaxis - the phenomenon of change of the pair of contact parastichies due to changes in the diameter of vegetative shoots at different levels. A pair of (3:2) with increasing diameter of the cone is changed to (3:5) and then (8:5) etc. With decreasing radius on the opposite end of the cone there is the reduction of (8:5) – (3:5) – (3:2), etc. explanation. [1]

1.2 Symmetry on the plants

In mathematical terms the symmetry on the plants shoots with spiral leaf arrangement belongs to *the similarity symmetry*.

1.2.1 Similarity symmetry

In similarity symmetry, the elements are dilated by a scale factor. They retain their shape but either stretch or shrink in size. This type of symmetry is gaining attention because of its relation to fractals.

In spiral or helical symmetry, the piece exhibits a spiral or helix. In other words, there is a central vertical axis that the piece "winds" around and either toward or away from.

Ornamental pinecones usually can be described by the rotational symmetry.

1.2.2 Rotational symmetry

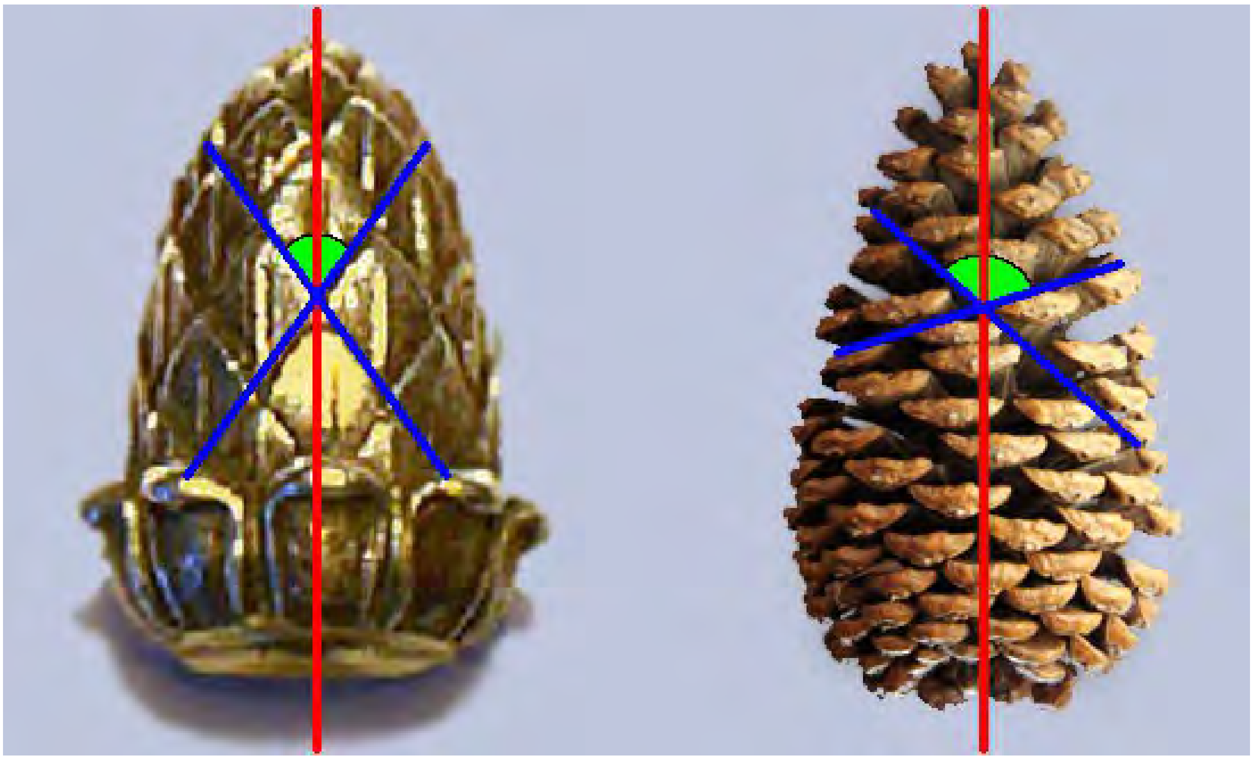
With Rotational Symmetry, the shape or figure can be rotated and it still looks the same. How many matches there are as you go once around is called the *Order*. With Rotational Symmetry, the shape or image can be rotated and it still looks the same.

In other words, one can rotate (or turn) an ornamental pinecone around a center axis by less than 360° and the pinecone appears unchanged. But with a vegetable pinecone it cannot be done.

1.3 Ornamental and vegetable pinecones

Table 1 Differences of vegetable and decorative pinecones

	Ornamental pinecone	**Vegetable pinecone**
Type of Symmetry	Rotational Symmetry	Similarity Symmetry
Number of right and left contact parastichies	The same	The different. Typically, the neighboring Fibonacci numbers.
number of contact parastichies at different levels of pinecone	The same	The different because of the rise phyllotaxis.
slope of opposite (right and left) parastichies to the direction of the pine cone axis	The same	The different
whole pinecone shape	Regular	Can be deformed.



Picture 2. Opposite (right and left) parastichies slope (blue) to the direction of the pine cone axis (red) at a work of art and at a natural pinecone.

The Pigna in the courtyard of Vatican is very much look like the natural pinecone.

Of course, when the first time I looked at the Pigna, I noticed only the deformation and different slope of opposite parastichies. I really wanted to calculate its parastichies, and such an opportunity! I do not want to belittle the artistic and historical value and other architectural treasures of the Vatican, but the Pinecone in the Giardino della Pigna represented for me the particular savor.

Our meeting took place. I behaved to her as the paparazzi. I did a lot of shots with my camera. To my great regret, I have not had the opportunity to take pictures from the part of the museum wall because of the fence. I am not professional paparazzi. The incompleteness of the picture presented difficulties for the work. I found some suitable images on the Internet, but so far I'm not sure about the absolute accuracy of my calculations carried out in Moscow.

The results of my work: Description of the morphology of the cones Vatican.

2. More detailed analysis of the anatomy of the Vatican Pigna

2.1 Number of parastichies in the pair of opposite families

Unfortunately, for the above reason I cannot vouch for the accuracy of counting the parastichies number in families of opposite parastichies of Pigna. Rough calculations yielded numbers close to 9 and 12.

Let parastichies pattern on a wide part of cone correspond to phyllotaxis (9:12) = 3 (3:4). (3 and 4 are members of the Lucas series 1, 3, 4, 7, ...). The presence of a common factor 3 relates this pattern to the category *multijugate*. In multijugate phyllotaxis, two or more botanical elements grow at the same node. Elements in a whorl (group of elements at a node) are spread evenly around the stem. Multijugate patterns look very similar to spiral.

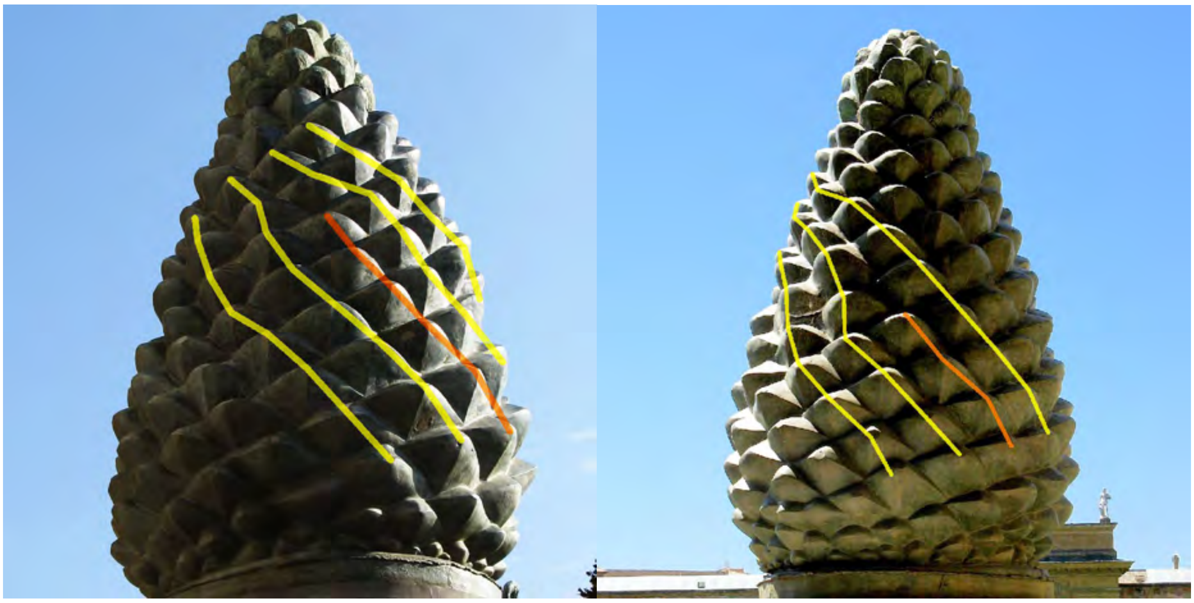
Anomalous phyllotaxis is extremely rare in the pinecones. Usually, they strictly follow the classical Fibonacci series. However, I have kept a pinecone from the city of Haifa (Israel) with phyllotaxis (6:9) = 3 (2:3). (2 and 3 are members of the Fibonacci numbers).

On the other hand, (9:12) ~ (8:13). The (8:13) is a classical Fibonacci pattern of phyllotaxis.

In any case, this question of the parastichies number in families will receive a response after an additional measurement of the Pigna.

2.2 Rising phyllotaxis

At the Vatican Pigna one can observe the phenomenon of *rising phyllotaxis*. At different levels of stem the numbers of contact parastichies are different. At the wide part of the cone the number is greater than at the narrow parts.



Side view   Rear view

Picture 3. Rising phyllotaxis. Some parastichies (orange) do not reach the top. The number of parastichies on different levels of the Pigna is different.

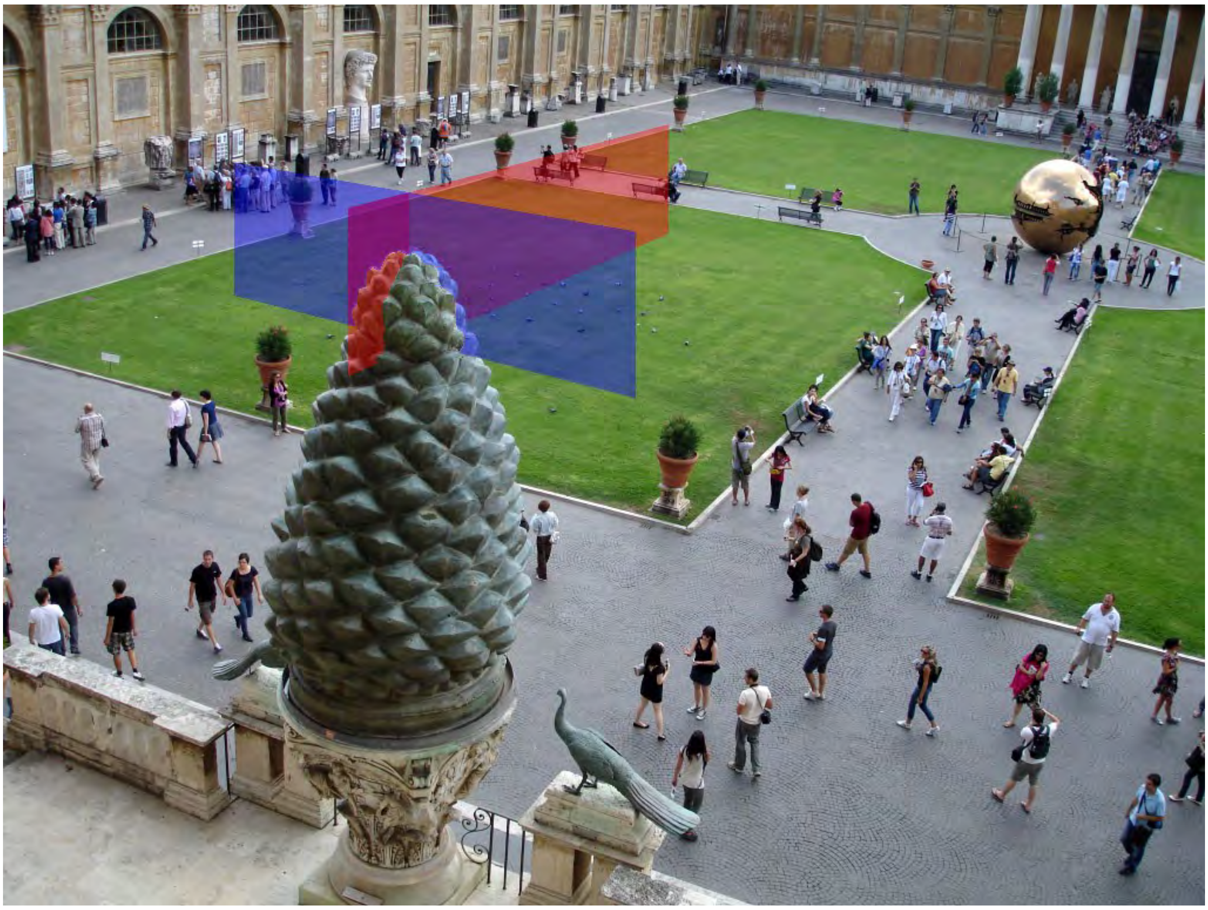
2.2 *The Pigna symmetry is ambiguous*

At the first blush, the Pigna corpus is monolithic, but in fact it divided into two pieces: the body and the cap. The boundary of these fragments is barely visible seam. The texture and color of the cap surface also differ from those on the body).

There are indications in the fall of cones during the storm, possibly as a result of lightning [2].
From the same source we learn that it is this pinecone, which, according to the author, formerly crowned the dome of the Pantheon, Vitruvius called the flower. From a mathematical phyllotactic point of view, there is no difference between pinecone and flower.

Picture 4. The Pigna corpus is divided into two pieces: the body and the cap.

You could pay no attention to the fact, but the symmetric properties of the cap and the body are qualitatively different.
The cone body has the symmetry properties of the similarity.
The cap has a mirror or bilateral symmetry properties, i.e. the cap is divisible into equal mirror halves.



Picture 5. The cap has a mirror or bilateral symmetry properties.

The top has two planes of mirror symmetry:

The median (sagittal) plane of symmetry coincides with the plane of symmetry of the courtyard.

The frontal plane is parallel to the wall of the museum behind the Pigna.

These planes are perpendicular to one another. The line of intersection coincides with the axis of the cone. Around this axis, we observe the symmetry of similarity of the body.

One can only speculate about the reasons for such eclecticism. Perhaps the original cap was destroyed and in its place was put a patch which is different from original? Restorers by this time lost the knowledge of phyllotaxis, or at least powers of observation of ancient sculptors (the Pigna was modeled and cast during the first or second century CE). The restorers completed the creation of the piece according to their notions of symmetry.

Surprisingly the body of the Pigna looks newer than the cap. It is interesting to note that the tip scales of natural vegetative pinecone are younger than the other ones, located closer to the pinecone basis.

3. Conclusion:

The Pigna is an artwork (not a copy of a natural pinecone). Otherwise, with great probability would be the pattern of the Fibonacci numbers (it is possible). Let's wait for additional measurements.

This conclusion reached in the absence of assumptions about other possible reasons of numerology. One can calculate not only parastichies, but the cone scales. Perhaps a more detailed mathematical, historical, cultural, and other analysis will propose other hypotheses.

The ancient master P. CINCIVS P. L. CALVIVS possessed powers of observation and knowledge, which later were lost. He was close to nature.

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Enrica Colabella

Paper: **Rhythm in Generative Art**

Topic: generative art

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www.generativeart.com

Abstract:

homage to Rimbaud

The linearity of our time is yet finishing.
No more *black* hours for discussions about **future**:
We are just lost in our *gray* present.
Without any doubt, presidents go ahead
For combining lives only at their *red* best price.
But on human shoulders is still alive the *blue* infancy **dream**,
Able to generate the splendor sound of visions.
Generative art is an imagining rhythm of mind,
Just a smile on a lovely face , a yellow instant….
Mixed between darkness and rainbow,
In silence, just a terrific frame in touch.
In the lighting eyes is forever hidden
The eternal beauty of resonance.
Generative art is a performing rhythm of life beat.
Only the east wind generates the *white* smell of an *emerald* **spring**.
future; dream; spring, in over press as **spreading**

GA is a performing process by discovering resonance between our own singular rhythm and the eternal universal rhythm. The main historical representation of this generative process is labyrinth/garden/book, as expression of a natural/artificial site.
The process is performed between two entities in walking. Initiate and magister, as two aspects of the same generative rhythm in transformation; because they enter step by step, *from stain to tree*, in resonance. The resonance generates memory, as active part of knowledge. Through our artwoks, If we are able to generate memory activities in people , we cross the borderline of art . The sound of resonance is activated... we gain the centre of labyrinth. Investigations about Renaissance: Leonardo, Alberti, Michelangelo; and about resonance tools and technologies. *Crossing dimensions*: Picasso; Pollock; Roth. Hypnerotomachia Poliphili. *Nostalghia* and *incompiuto*: Michelangelo - Bach - Puccini ; Tolstoj *last station*

The ship of Cupid, from Hypnerotomachia Poliphili

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Keywords:
Generative art, rhythm, resonance, labyrinth, *metamorphosis*.

Rhythm in Generative Art

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Abstract:

homage to Rimbaud

The linearity of our time is yet finishing.
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Following my investigation about *numbering in resonant silence* [1], as a moment in a generative process able to identify a performed bivocal art (math+poetry) [2], the focus of this paper is rhythm in its ability to generate *resonance* for gaining complexity in generative artworks. Resonance between a past (moment 1) and a present/future (moment 2),
as the biologic beat heart between *first* the ***generation*** of electrical impulses and
second their **spreading** across the heart. This process is performed between two entities in walking. Initiate and magister as two aspects of the same generative rhythm *in transformation*. because they enter step by step in resonance. Resonance needs the time of memory, as a labyrinth topology. It works in endless human experiences. So resonance is generated from memory, as an active part of knowledge. If we are able to generate memory activities in public through our artworks, we cross the borderline of art. The sound of resonance is activate. We gain the centre of labyrinth, by discovering the resonance between our own singular rhythm and the eternal universal rhythm.
The main historical representation of this process is in Renaissance, in the theory of Ficino, experimented by Leon Battista Alberti, Leonardo, Michelangelo. Resonance in crossing dimensions, from 1, 2, 3 and more and in reverse way. Labyrinth; Picasso, Guernica; Pollock, Pasiphae; P. Roth, *"The Human stain".* Actual scientific resonance experimentations in natural sites. The last station of Tolstoj He made his last fugue, stopping for health problems at the station of Astàpovo for dying in loneliness, as an *elephant*, following the resonance of Anna Karenina voice. She at the station of Moscow met her love Vronskij and at the same station killed herself going under a goods train. Until the extreme conscience of resonance in "*incompiuto*" (unfinished) : Michelangelo – Bach – Puccini.

The ship of Cupid, from Poliphilus

Over the well known definitions of resonance in scientific disciplines, focus of this paper is the rhythm able to generate resonance between 2 different boundaries.

1 - Discovering resonance: *music* in Renaissance

In Renaissance the vision performed by Ficino was that all human activities have the tendency to celebrate the ineffable beauty that reigns in the universe, all arts contemplate to the superior harmony that must be called ***"music"***: its first degree is in ***the reason***, the second one in ***the imagination*,** comes subsequently the discourse, **the song**, and more ***the sound of the instruments***, and at the end the movements of ***the rhythmic dance***.

""The music of the mind from degree in
degree comes down and it conducts to all parts of the
body. Which also orators, poets, painters,
sculptors, architects in their works go imitating"

This idea of music represented therefore a perfect symbol of the artistic activity with its three aspects: *the music instrumentalis* is only ***the first*** degree, *the internal music (humana)* of soul is ***its second one*** and *the cosmic music (mundana) the higher* degree.

Music comes so to be connected to all the degrees of the being, touches both the inferior conscience, tied up to the physical nature, both the *illuminated conscience* that enjoys *the numbering beauty* and the superior conscience that gathers a *transfigured* universe.

The *" the lira of Orpheus "* means the access to the happy intuitions; it is a remedy to the hidden pains of the soul and in first place to the **melancholy**.

As it was justly observed, the practice and the theory of the music knows, around 1500, thanks to the increase of the octaves and of the enrichment of the families of instruments, the same amplification that *permutes the conception of cosmos,* which expansion is clear in Ficino, as in Nicola Cusano, ***before*** Copernico: **octave** draws a sort of perfect circle, the musical accord is in certain way the prototype of the pure beauty.

It is interesting to focus as the call to the music is successful in that we could call the art criticism in '400. In the instructions given to Matteo de' Pasti, **Alberti** insists on the *measures* and *proportions* of the pillars for which to modify would mean to destroy in them **the accord of the whole music**. We have here an analogy very meditated, founded upon the pure value of number, and together one of those "***metaphors of value***" able to reveal a new orientation of the sensibility.

1 – 2 Hypothesis:

Thanks to the hidden musical harmony inside the ancient Italian buildings, able to generate resonance, we can gain pleasure still to-day in visiting them, as contemporaneous *flaneur*. They are for young generations as open books to

discover, for learning the incredible art of architecture. The hope is that teachers love to indicate structure and tools.
Going back to Florence in Renaissance. about this process of musical harmony , Ficino felt the need to give a **philosophical interpretation** of it. Leonardo would have assembled his attention on the relationships among painting and music that it is sister but it not at the same height of painting.
In fact the "*unfortunate music*" for Leonardo ("unfortunate" because destined to dissolve itself in the air) becomes at the end to be inferior to the painting in the same measure in which the hearing is inferior metaphysically to the sight, so the harmony that develops in its duration is inferior to that is unfolding in the space.
The main focus for Leonardo art is not poetics, bur ***enigma in painting***. When you observe his artworks you have the deep impression of staying in front of a something to resolve by interpreting. When you arrive in solving the enigma, following a possible your interpretation, suddenly you enter in resonance with his artwork, perceiving not a solution, but mainly the entity of mystery. Not in random way Leonardo wrote tales, but following exactly this process of encoding the mystery of life, as the ancient oral tradition performed. About the code of tales see my paper Mater matuta [3].
For condemning the *sentimenta*l painting of Flemish artists, that it seems him detestable, Michelangelo will resort to the same formula of Alberti:"… *this bad painting is made for pleasing to women, to monks and "to some gentleman deprived of **the musical sense of the true harmony**"*
This sentence induces to think that the reference to the music had been already for long time current element of the language of arts. The tradition narrates that in the *bottega* of Verrocchio was held a lot to the music; **Leonardo in his youth is known as chorister and performer of lira**: a miniature represents him with this tool in his hand.
.

2 - Rhythm and words resonance

In our digital times, punctuation is perhaps totally disappearing; so we losing one of the main tools able to perform a rhythm inside a text, Or better it had lost its identity as the structural part of a text, as the hierarchy of the text syntax, by performing the pauses, the connections and the discontinuances. Today the unfledged writer tends to second, with the punctuation, the rhythms of the speech, trying to reproduce its pauses. The punctuation is therefore often modulated on the times of the respiration, losing its principal function that is that syntactic, as intervention on the sense of the sentence. So we can delineate with the tool of punctuation an order in which each part enters in resonance with the others performing a rhythm in our mind when we read and in the voice when, following the punctuation rhythm, as able readers we modulate our voice for other people. After a lot of discussions on *"Is the semicolon worth saving?"* (from D'Alembert to Orwell) in her recent best seller English book "*Eats, shoots &leaves: The zero Tolerance Approach to Punctuation"* Lynne Truss says that *it is time to look at our commas and semicolons and see them as the wonderful and necessary things they are.* This seems to open a new front for preserving these tools, necessary for indentify a text rhythm.
"Per un punto Martin perse la cappa" (For a dot Martin lost his hood");
Martin wrote on the top of the convent door:
Porta patens esto nulli. Claudatur honesto ("The door doesn't stay opened for

anybody. It is closed to the honest man" , instead of:” *Porta patens esto. Nulli claudatur honesto” ("The door stays opened. It is not closed to any honest man")*
This ancient popular sentence says in a dot more than with a lot of words.

2 . 1 Hemingway in 6 words resonance

Ernest Hemingway made this story in 6 words**:**

”*For sale: baby shoes, never worn.*”

When he finished it, he said that it was his best opera.[4]

In internet there are 329 replies to the call for the imitation of this story in 6 words in http://www.sixwordstories.net/2008/12/for-sale-baby-shoes-never-used-ernest-hemmingway/
But computers are only tools!
You can read a lot of results in 6 words in internet, but no one is literature.
They have not made any attention to the structure of the text that is really very ancient: it is a trilogy.
1 An antecedent, defining the main condition
2 an acting in an object
3 a character
Inside this dynamic structure you can discover a lot of different interpretations, all belonged to the same text, connecting the sequences for performing a story
This is poetic literature, the ability of Hemingway to generate inside the text endless interpretations, all congruous to the text system.

2 – 1a Six principles

In 550 AD Xie He, an art historian and critic, wrote: “ Six principles of Chinese painting”:

*1- "**Spirit Resonance**," or vitality, and seems to translate to the nervous energy transmitted from the artist into the work. The overall energy of a work of art. Xie He said that without Spirit Resonance, there was no need to look further.*

2- "Bone Method," or the way of using the brush. This refers not only to texture and brush stroke, but to the close link between handwriting and personality. In his day, the art of calligraphy was inseparable from painting.

3- "Correspondence to the Object," or the depicting of form, which would include shape and line.

4- "Suitability to Type," or the application of color, including layers, value and tone.

5- "Division and Planning," or placing and arrangement, corresponding to composition, space and depth.

6- "Transmission by Copying," or the copying of models, not only from life but also the works of antiquity.

In Chinese art the main aim is to reveal artist as a custodian of the past, for the recognition given to a master. The overall effect of the gentle and peaceful art of Chinese brush painting, which are sometimes known as ***voiceless poems***, should be one of freshness and spontaneity. The qualities sought are vitality of spirit, intensity of realization and freshness of perception. Such is the nature of the painting materials that before setting brush to paper the artist must hold a well conceived draft ***in the mind's eye***, as once the painting is started it is not normally possible to alter a wrong stroke.

3 . Discovering resonance in painting
About emergence

"perché dalle cose confuse l'ingegno si desta a nove invenzioni"/ "because from the chaotic things the talent arouses itself to new inventions"

"Oh don't see you, that the eye embraces the beauty of the whole world? It is the head of the astrology, it delineates the Cosmography, it all human arts recommends and corrects... it is prince of mathematics... it has generated architecture and perspective, and the divine painting... Oh, it is the best excellent over all the other things created by God! Which of praises were those able to express your nobility?"

Leonardo, "Essay of Painting"

In a famous chapter of the Essay of Painting (Lu-66, McM76) Leonardo comes down from the casual stain on **a wall to the figuration as in an hermeneutic procedure**: the stain is the text and the figures, that there are imagined, are the interpretation of it. As modern painters we have also learned **the inverse procedure to translate the figures in stains**. But this going and return *from the text to the interpretation and from the interpretation to the text* it was not quite extraneous to Leonardo [6]

In this process Andrè Chastel [7] recognizes a Neoplatonic attitude.
This contemplation of ***the mobile stains***, that in nature are seen for a curious coincidence, takes back a practice of **the Chinese painters**. The dreams, at open eyes, increase the receptiveness of the subject and guide the active imagination, exactly as the vacatio animi (the soul void), as **the state of distraction** that Ficino recommended because the spirit could be the true speculum of the hidden reality.

A similar procedure we can find in Alberti and in the landscapes from him "***intenzionati***" (designed with intention); these are lived as they are, through the scientific analysis of his *aerial* perspective that is, in fact, **perspective of memory.**

4 - Resonance between stain and mind

Justinus Kerner [8] was a romantic poet of '800, on his texts Robert Schumann wrote *12 poems by J. Kerner op. 35*, and we was a doctor too. He discovered Botox toxin and he was a pioneer on the psychic research. Going ahead with age he observed that his trembling hands allowed to fall drops of ink on the pages that went writing. Instead of putting away those sheets of paper, he got to systematically study the forms of the stains and the images able to evoke them in his mind back, inspiring him sometimes also some poetries. To his work on this matter, ***Klexographien***, published in 1857 and mixed to artistic and poetic considerations, sixty years later Swiss psychiatrist Hermann Rorschach would be inspired for conceiving the psychological test, today called with his name.

Klecksographie with autograph poetry

J. Kerner**,** ***Klecksographie*** *"… very slim / to rise the beautiful butterfly. / To such transformation I confide / to God my soul……. "*

5 - Resonance by crossing dimension: labyrinth

Daedalus and Pasiphae *fresco, 60-79 A.D. Pompei, House of Vetti*

"Las calles de Buenos Aires / ya son mi entraña"
Borges, Les calles

For defining a generative art process we can use the metaphor of *the voice of the cantor de tango,* that crosses the city in a quartering process through two perspectives possible: one vertical and second horizontal, as a labyrinth This double direction generates the shape of result, ***as memory, vertically*** it sinks in the wells of the past, in reactivating to give it a configuration in the present time, that becomes intimate since *introjected*. In this part of the generative process the *abduction* from reality becomes open to a process continually doubled. In which from a remote antecedent, as a past soaked of narrations and of omissions, every result - expressly or potentially - is able to delineate a performing resonance more and more. This generative result is realized stratified, founded upon a series of temporal overlaps that is able to extend, retrospectively, toward endless. So in this first direction the song proposes itself as an *analogon* of memory, to it tightly connected. As memory the GA process turns back and returns in fragments of departed things; as memory, it comes to flashes, appearing in moments - and in places - that it is not possible entirely to foresee; as memory, finally, the song not always knows with precision what it will make to resurface, also unfolding itself in first appeal as a precise and deliberate operation, from the abysses of the past.

The memory is therefore part constitutive of the process foundations, and in this vertical direction it is gathered all of its importance: without a definite action that turns to generate and to conclude certain portions of past, the same present would be somehow more precarious, leaning on fragile legs. This vertical generative process reminds to the vision of *Angelus Novus, by W. Beniajmin*. It is animated by the wind of history, but with the turned eyes firmly back, to what precedent has been.
As it is the survive in labyrinth.
The horizontal direction more directly brings back instead the generative process to the understood data as concrete configurations: the itinerary is drawn among the process paths. It is ***the voice*** to unravel the thread that ties between them the various steps, and to determine the crossed as a compass. In first place it is clearly made reference to voice, able to evoke the memoirs of the past and contemporarily to affirm its actual presence, making to detach, *in the iter of process,* **the island** that it touches.

6 - Hypnerotomachia Poliphili – The island - garden of Citèra

Hypnerotomachia Poliphili is a book designed as garden, published in Venice in 1499 by Aldo Manuzio, and written by Alberti or Giovanni Pico della Mirandola, or by Francesco Colonna, following an acrostic from the 38 chapters of the book. This is able to express deeply the culture and ideals of Humanism, reflecting the principia of neo-platonic philosophy. The book is a metaphor of the initiated travel made by Polifilo, hero of " *the battle of love in dream".* It was a font of interest for all researchers for the ideal garden, that is configured by the island of Citèra. (fig.1)

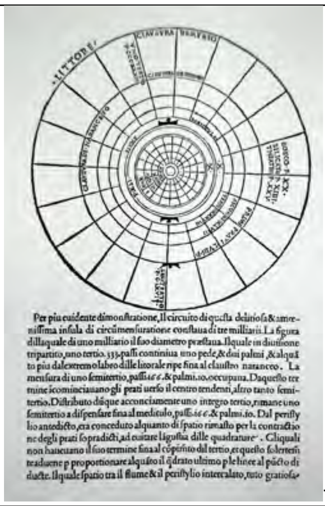


fig.1


fig.2


fig.3

Citèra is the synthetic representation of all principles of **an humanistic garden**, as a labyrinth. Polifilo talks about his love for Polia, first lost and then met again after a travel made in dream during the ruins of antiquities. This is the travel of a visionary man in a circular island with in center an amphitheatre where they assist to Cupid triumph. In the amphitheater center there is a fractal circular temple. Polifilo cross the veil on the door and they can see **Mater Amoris**, the sacred font as symbol of the tree of life. Then **Polia** talks about the origin of her people. ***Two parts***, each one in resonance with the protagonist. The circular topology is emphasized by drawings , ascribed to Andrea Mantegna, with scripts that fellow a predefined form (fig.2).

Image run in the book in **an order totally free** by text . *Polifilo and Polia* are expression also in their names of the plurality significance, that starts from a visionary process. The book is made as a symmetrical connection inside the singular parts. The trees (fig.3) are represented in their uniqueness by the same logics of the island. In few words all these creative logics of representation are connected in a topological circle, but each one reveals itself autonomous in the plurality, This is really a representation of a GA process!

7 - Rhythm and painting resonance

As a labyrinth Pablo Picasso painted *Guerniga* ((after 45 draft schemes) in 1937. In this incredible artworks the 2 directions vertical (y) and horizontal (x) coexist but never squared. The *artificium* elaborated by Picasso was to perform x as in axonometric perspective, given to x the limit of a function inverted of x toward 0, that has the result of infinite. In this way all the horizontal are absorbed by the shadows, that become an hidden *stain* full of resonance. So he gained an accurate 4D, able to generate impressive emotions over all times.

Guernica evokes Benjamin definition about labyrinth as a synthesis of the twin terrors *"monotonous wandering*". It points out a sort of "country of the hesitation", where are not privileged connections but only broken lines, reversing and interrupted, that intersect themselves, that find again together for then diverge. There it is hidden *"the correct street for who that will reach the destination in time however."*

Pollock , *Pasiphae, 1944*

In my hypothesis this picture was elaborated by Pollock, using as catalyst Guerniga.

But with spatial intention totally inverted, not for gaining 4D but **starting in simplifying** the vertical direction in a random sequence for platting any deepness, Pollock arrived to bring to maximum power ***the dripping***, the surrealist technique of psychic automatism. This becomes like a shout for the lost center. After "*God is dead* " by Nietzsche, man performs his metamorphic process in Minotaur. He discovers his animal nature as a destructive power; he becomes his fool run toward darkness, loosing in first any concept of space and time, becoming a whole with reality through his own metamorphosis in object. Man becomes a surface, a deep tragic song full of stain in a strong ruinous noise, **wasting any resonance**. This was a first step with the emblematic title Pasiphae, the Minotaur mother. Pollock preferred to call his artworks in this way instead Moby Dick, the first title. He run toward the progressive trip following the ***flat vision*** of a chaotic world, going back from an order without any feeling toward a disorder full of ***explosive fragments***. In his last days Pollock turned back to *forms in black* for his artworks.

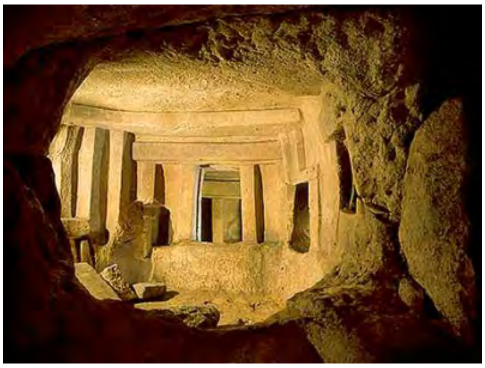
8 - Literature resonance

In 2000 Philip Roth wrote ***"The human stain"*** [9], set in summer of1998, considered "*one of the most provocative explorations of race and rage in American literature."* A classics professor at Athena College, Professor Silk made this question to his students about some absent students: "*Do they exist or are they spooks?"*This question opened a fractal process of discovering the bounders between truth and falsehood, past and present, perception and reality, and offered a moving meditation on the limits of what we can really know about each other. *The Human Stain* ends with Zuckerman finding Les Farley ice fishing in the middle of a secluded lake. Les says: *"And now you know my secret spot. . . . You know everything. . . . But you won't tell nobody, will you? It's nice to have a secret spot. You don't tell anybody about 'em. You learn not to say anything"* **And the fractal process turns back in circle, again.**

9 - Technology for resonance

The most beautiful thing we can experience is the mysterious.
It is the source of all true art and science.
Albert Einstein, Mein Weltbild (1931)

Archaeoacoustics: is the Science of Ancient Megalithic Structures. It is a science as yet in its infancy that is growing over all the world [10].Its main aim is in investigating and measuring the acoustic parameters of ancient places by use of electronic devices. In the islands of **Malta** and **Gozo** are discovered megalithic structures that were created by a highly developed people more than a thousand years ahead of Stonehenge and the pyramids. **Malta's Hal Saflieni Hypogeum** is an extraordinary example. It is performed by a multi-leveled complex of caves and ritual chambers, architecturally intact after five thousand years, in which was discovered that: *"There is a small niche in what we call 'The Oracle Chamber', and if someone with a deep voice speaks inside, the voice echoes all over the hypogeum.* ***The resonance in the ancient temple is something exceptional****. You can hear the voice rumbling all over."*


Malta’s Hal Saflieni Hypogeum

This is an example very significant and fascinating also for its underground architecture uniqueness. There are a lot of investigated sites over all the world: *Newgrange, Ireland* (constructed *c.*3200 BC); *Emain Macha (Navan Fort), Northern Ireland; Orkney’s Chambered Cairns, Scotland; Stonehenge, England; Chichen Itza, Mexico; Chavín de Huántar, Peru*. Across Europe there are thousands of tunnels – from the north in Scotland down to the Mediterranean[11]. “*Lithophones*” in Spain and france; “*Palaeoacoustic*” ringing rock sites on the shores of *Lake Onega in Russia*, studied by Russian and Finnish researchers; the United States have identified “*ringing rocks*”. *More recent work in the USA, Australia and elsewhere by American acoustic researcher, Steven Waller, indicates that some prehistoric rock art panels produce echoes that act like “soundtracks” to paintings of animals, simulating the rumble of depicted animal herds, for instance, or the roar of a lion or sabre-toothed tiger.*
*In Canada, the mighty cliff known as **Mazinaw Rock** rises out of Mazinaw Lake in the aptly-named Bon Echo Provincial Park, Ontario, produces exceptional echo phenomena. Along the bottom of the cliff face, just above the waterline, there are many dozens of red ochre rock paintings, produced about a thousand years ago by the ancestral **Algonquin people**. The echoes are particularly noticeable where these rock art panels cluster.*


Pictographs-Mazinaw Rock

There are also many experimentations about discovering sound and resonance, as Orkney’s chambered cairn [12]; in Bosnia the "voice" of *the Pyramid of the Sun*[13] and in 2005 Astronomer Scott Hyman of Sweet Briar College in Virginia has detected an unusual, powerful burst of intermittent radio waves emanating from the direction of the center of the *Milky Way*, through radio telescopes set at various wavelengths. [14]
In China *Longyou Grotto's, (Hand-Carved Caves)* were only discovered late in the 20th century. They are considered by Chinese to be the 'Ninth Wonder of the Ancient World'

10 - Rhythm and silence

Antefatto:

My vision about data of Tolstoj death is that, over all the congruous interpretations, narrated in books and movies too [15]*, his soul was oppressed by nostalghia. Nostalghia, a greek word, (nostos) home return and (Algos) pain, was a wonderful film by Tarkovskij, that defined this word in this way: " For us Russian, nostalghia is not a light feeling, but a deadly illness that it pushes to travel, without any possibility to stop". You say but nostalghia is a feeling for people that are out of their country. Tolstoj was In Russia, at his home, with his wife, with his family, with his doctor, it is absurd to affirm that he was in pain for nostalghia, almost before his death.*
But especially for artists that went in deep investigation in their art, it happens to feel nostalghia of their own imaginative world. In proximity to death they have a great conscience of their end toward their artworks too. It was not enough for Tolstoj to leave for free the rights of all his opera.
So with a tragedy action - almost surreal or romantic -, the Russian writer goes to die in the station of Astàpovo, run after from emissaries, reporters, curious, relatives, as an animal, an elephant (taking back the appellative by Proust). For me the explication is in his need and reaching of hearing again Ann Karènina voice, as unbreakable resonance of his art.
Ann Karènina met for the first time the love of her life Vronskij at Moscow station and in a station she decided to kill herself, by throwing herself under a goods train. Ann's end in reality is only the shadow that reflects a light of hope: the last resonance in Tolstoj at the Astàpovo, that now is called Lev Tolstoj station.

"From some part in the uncompleted"
R. M. Rilke in V. Jankélévitch, [16]

Following this particular feeling connected to the death of Tolstoj in a station of a small city, suddenly the unfinished artworks by Bach, The art of fugue, Michelangelo Pietas Rondanini, and Puccini , Turandot, were illuminated in my mind all by the same binomial expression of nostalghia/resonance. Also if they are expressed in their so great differences. They are able to connect us through their resonance art toward the silence of the tree of life. We can discover:
In Bach," The art of fugue": an immediate resonance: a catastrophic silence.
In Michelangelo, "Pietas Rondanini": a metamorphic resonance: his self portrait in Nicodemo.
In Puccini," Turandot ": his last music page: resonant embryos, ***as a stain.***

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ELIF BELKIS ÖKSÜZ

Paper: SIMULATING THE ORGANIZATION OF MULTI-CELLULAR ORGANISMS WITHIN THE FRAMEWORK OF SPATIAL RELATIONS IN ARCHITECTURE

Topic: Architecture

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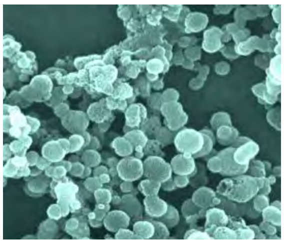
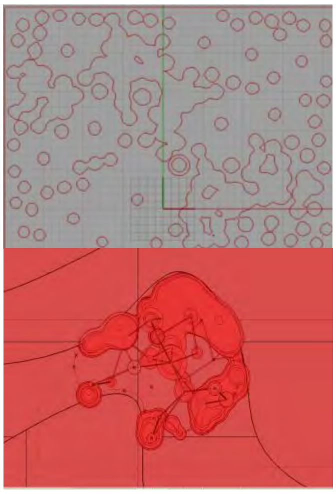
Abstract:
The design approaches inspired by nature throughout history, has become more significant and complicated in today’s architecture. Thanks to the advances in biology and its interactions between different fields, the nature can be used with its complexity in design. Within the use of computational theories and advance techniques in design field, the morphological processes of cellular organisms such as emergence, growth, and selection in natural sciences can be analyzed and used at a certain level in architecture. Considering the 21st century’s global changes, understanding and emulating these chaotic processes seems one of the effective ways of designing more sustainable future. One of the reasons for that is there are some remarkable resemblances in morphological processes in nature and human civilizations. In this study, it is aimed to focus on some of these chaotic processes in an architectural frame by simulating the organization of single and multi-cell organisms in nature within a spatial framework.



Nanobacteria-like particles from human blood [3]

In nature, with a specific genetic code, the basic structure of a living system, a single cell, combines with its likely neighbors and creates tissues. As these tissues become organized with their neighbors and create clusters by their particular obligations given by their genetics, they generate the parts of a living system. Considering these neighborhood relationships between cells and tissues of cell organisms, it is possible to say that these connections between units which differ from cell to cell or tissue to tissue are the essentials for survival of an organism. There are different roles of these connections between these similar units and clusters which help to create a sustainable arrangement. Indeed, that is a common point between architectural design and biology. For the reason that, in architecture, we also need an effective organization and strong relationships between spaces for efficiency in our design. From smallest to largest scales in design, organizations of spatial relationships are the most key facts of a sustainable design. Thus, this study offers some architectural living models within the physical and social relations of design units in different-scales, by simulating the organization of cellular living systems.



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Keywords: Emergence, spatial relations, cell growth, chaos and complexity in architecture, network systems, genetic algorithms

Simulating the Organization of Multi-cell Organisms within the Framework of Spatial Relations in Architecture

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Abstract

The design approaches inspired by nature throughout history, has become more significant and complicated in today's architecture. Thanks to the advances in biology and its interactions between different fields, the nature can be used with its complexity in different stages of design. Within the use of computational theories and advance techniques in design field, the morphological processes of cellular organisms such as emergence, growth, and selection in natural sciences can be analyzed and used at a certain level in architecture. Considering the global changes of the 21st century, understanding and emulating these chaotic processes seems one of the effective ways of designing more sustainable future. One of the reasons for that is there are some remarkable resemblances in morphological processes in nature and human civilizations. In this study, it is aimed to focus on some of these chaotic processes in an architectural frame by simulating the organization of single and multi-cell organisms in nature within a spatial framework. In nature, with a specific genetic code, the basic structure of a living system, a single cell, combines with its likely neighbors and creates tissues. As these tissues become organized with their neighbors and create clusters by their particular obligations given by their genetics, they generate the parts of a living system. Considering these neighborhood relationships between cells and tissues of cell organisms, it is possible to say that these connections between units which differ from cell to cell or tissue to tissue are the essentials for survival of organisms. The different roles of these connections between these similar units help to create sustainable arrangements. Indeed, that is a common point between architectural design and biology. Similar to nature, in architecture, we also need effective organizations and strong relationships between spaces for efficiency in our design. From smallest to largest scales in design, organizations of spatial relationships are the key facts of sustainability. Thus, this study focuses on the physical and social relations of design units in several scales by simulating the organization of cellular living systems.

1. Introduction

For efficiency, aesthetical concerns, and sustainability of production, the use of nature and natural forms can be seen in many fields as well as design. From structure to ornaments, nature has been used in several ways for different purposes of architectural design so far. However, for the 21st century, nature is considered more with its scientific values and is applied in design more comprehensively. Thanks to the advances in biology and its interactions between different fields, nature can be analyzed and used with its complexity in design. Within the use of computational theories and advanced techniques in design field, the morphological processes of living organisms such as emergence, growth, and natural selection of forms can be analyzed and used at a certain level in architecture.

Considering the global changes of the 21st century, the understanding and emulating these chaotic processes and adapting them into design process appears to be one of the efficient solutions for designing more sustainable future. One of the reasons for adapting these natural concepts to architecture is the similarities between the morphological processes of nature and civilization of humans. Especially, as dynamics of nature, the organizations of living systems are highly related to the logic of human civilizations. Both organizations form through their functions, capacities and relationships between their members and the environment over time. Therefore, if some of these strategies are described at a particular level, they can be applied in design field to create effective solutions for architectural design.

2. The Development of Living Systems as Natural Forms

2.1 Chaos and Complexity of Natural Forms

Natural forms are often developed as organization of units in variety of scales through time. All living units, emerge, organize and survive or die depending on environmental circumstances and their design principles given by genetics. These morphological processes mostly rely on the chaos and complexity as two significant features of natural events. These features usually can be seen as determining facts of the emergence and the self-organization progresses of units. As generative progresses of nature, emergence and self-organization of forms are often as chaotic developments within different complexity levels in time. All natural forms occur in chaotic order in variety of scales, changes gradually or instantly through time. While some of these developments and their changing values can be recognized as physical forms, some of them cannot be tracked due to timing and different scales.

Although the emergence and organization of units seem complicated and random, there is always a chaotic order of predefined spatial relationships of units with several constraints and no randomness in these progresses. According to Flake, “Chaotic systems can be easily mistaken for randomness despite the fact that they are always deterministic. Part of the confusion is due to the fact that the future of chaotic systems can be predicted only on very short-term time scales. Chaotic systems possess a form of functional self-similarity that shows itself in fractal strange characters. This fractal functionality, combined with chaotic unpredictability, is reminiscent of the uncertainty found in computing systems."[1] No matter how complicated that the natural systems are defined, the constraints of systems may also change in short term or long term, due to their given genetic information and environmental circumstances and cannot be followed completely. However, most of the changes of these constraints depend on the basic elements' genetic description adaptation to environmental circumstances. Therefore, in order to determine the chaotic order and complexity of systems over time, it is important to describe the basic elements of these systems and expose the relationships between their affiliated units and the environment. When these progresses and adjustments of these features adapted to into architecture, they do not have to be taken as complicated as nature. Although, best results of design developments would come with adapting the exact logic of nature, it is not easy to identify the whole complexity and basics of natural forms and adapt them into architectural design directly. Though, it is possible to identify the physical formation of natural forms by analyzing the organizations of their simplest structures as 'cells' and adapt them at a certain level into architecture. In order to create 'living solutions', the spatial arrangements of units both in nature and architecture should be in specific order which changes quickly or slowly depending on selection of units through time. To adjust these features of living forms to architectural design development, the development of cell-organisms as living systems can be examined and deliberated within several physical constraints.

2.2 How Cells Create Tissues and Natural Forms

In order to adjust the strategies of morphological progresses of living organisms within several constraints to architectural design, basic structure of these living forms should be examined in particular points to determine the most important ones. In nature, with a specific genetic code, the basic structure of a living system, a single cell, combines with its likely neighbors and creates tissues or living systems depending on their genetic design information. As they (tissues) become organized with their neighbors and create clusters by their particularly given obligations, they generate the parts of a living system. Considering these neighborhood relationships between cells and tissues of organisms, it is possible to say that these connections between units which differ from cell to cell or tissue to tissue are the essentials for survival of an organism.

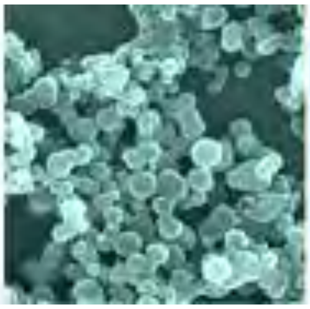


Fig.1 nanobacteria-like particles from human blood as uni-cell organisms
Fig.2 human body and inner parts as multi-cell organisms

In a biological description, cell organisms, “exist at the subcellular level; i.e., the basic functions that are divided among the cells, tissues, and organs of the multicellular organism are collected within one cell. The development of multicellular organisms is accompanied by cellular specialization and division of labor; cells become efficient in one process and are dependent upon other cells for the necessities of emerge and organize, according to their genetic information.”[2]

Within this view, the significant similarities can be realized between the development of living systems and architectural organizations. Just like the logic of nature, in architectural design, we also consider the relationships of each unit within physical and social functions of spaces and organize our living environment with the same strategy. Every unit of design forms by these relationships with environment and other members of the system. The most important point of these types of design development, it helps to identify the physical and social relationships between spaces and spatial values of spaces. As a common point of architectural design and biological design, each connection of these similar units and clusters has specific roles and help to create sustainable arrangements. Also, each complex system represents the heterogeneous organization of nature.

Therefore, one of the ways of creating socially and physically sustainable living environments is to create complex and integrated systems through these heterogeneous organizations. The term ‘heterogeneous’ is considered as one of the characteristics of complex systems of nature. Hensel and Menges suggest that “The complex is heterogeneous, with many varied parts that have multiple connections between them, and the different parts behave differently, although they are not independent.”[3] In architectural design, heterogeneous spaces can be formed by the defined relationships between users, functions, materiality and the environment. To create heterogeneous solutions for the design, the order of chaos and level of complexity must be defined in specific constraints. In this study, to generate these spaces through nature’s logic, the progress of space development in architecture is considered as living organisms in variety of scales. From smallest to largest scales, defining the spatial relationships of architectural units like natures logic is one of the possibilities to reach a sustainable arrangement of architectural forms.

3. Architectural Spaces as Living Organisms

Although, there are numerous known and unknown features of emergence and organization of natural forms, the basic principle of most of these chaotic structures depend on the complex physical relationships of their simplest units. These morphological processes generally are contingent on the inner and outer relationships of their simplest parts and manipulated by their genetics, and environmental circumstances. Some of the principles of these living solutions can be adapted and applied to architectural design process at certain levels. Like living organisms, the emergence and growth of human civilizations follows the same logic of nature’s relationships, only in simpler and slower way. According to Weinstock, “All forms of nature and all forms of civilization have ‘architecture’, an arrangement of material in space and over time that determines their shape, size behavior and duration, and how they come into being."[4] However, once the nature's logics are applied to design process, one must be aware of dealing with the complexity and chaotic order of nature's progress. Besides, to adapt not only the form, but also the logic of nature in design, the progresses should be simplified to its organization principles.

Even though, the units form freely by their functions within spatial constraints, they are not entirely independent. The cells are formed by the environmental and other units also. According to Flake, "… the complex systems that we simulated included insect colonies, flocking groupings, greedy game players, ecosystems, and statically wired neural networks. Clearly, the natural phenomena that these systems resemble exist on very different spatial and temporal scales. Moreover, the components of these systems also have varying amounts of sophistication: from single cells all the way up to relatively smart animals. However, each of the complex systems has a global behavioral pattern that depends directly on how closely and precisely the components are 'wired' together…..Systems that are tightly constrained fall into persistent static patterns. In between are systems that exhibit global patterns that are more than either of the extremes."[5] Considering this, it can be said that all complex systems in nature are wired (have networks) due to their different spatial and relational values. When these connections are tightly constrained to each other, they create more static patterns; otherwise, they create more flexible forms. The principle of nature relies on the functional and relational communications between its components. Therefore, one of the best solutions to define these functional and relational communications of space is to use network strategies.

3.1 Connecting Spaces by Networks Strategies of Nature

While the term 'network' is generally stated in communication field, the strategies of network systems, the logic of network has been widely used in several disciplines as well as in architecture. The term network is defined as "an abstract organizational model, in its broadest sense concerned only with the structure of relationships between things, be they objects or information, which can be applied to the organization of anything from friends lists to genetic algorithms to global military operations."[6] In general view, networks are the invisible connections between simplest units of forms and show how these units are related and connected to each other. It is possible to say that the morphological process of living organisms are formed by the constraints of networks, reflections of environmental conditions and genetics.

In order to adjust the systems of living organisms to design development and create heterogeneous spaces, the features of the systems can be limited to several constraints such as functional arrangements and distance relations of units through time by network systems. To control the emergence and organization of architectural spaces, several invisible 'wires' can be exposed or created between design units by applying network strategies to process. However, it is not entirely possible to control and limit the morphological process of living organisms, and civilization of humans with several limitations. Though, it is possible to create somewhat predicted solutions for growth of architectural element and to design well-organized and heterogeneous systems for living.

Since the emergence and organization of all forms are based on chaos and complexity in nature, there are numerous features manipulating these progresses. Although it is not possible to adjust all these characteristics of nature's design, some of them be simplified and manipulated in architectural design process. In this view, in order to create functionally and socially efficient heterogeneous spaces, creating connections between units within the physical and relational features and living environment is one of the characteristics of natural formation.

4. Case Study

4.1 Emergence and Growth of Living Spaces

When adapting the organization of cells into architectural design process, the arrangements of relationships between cells can be described in building scale within different functions or specifications such as living units working units or private/public spaces or deeper conditions depending on the strategy level. Also, is important to consider the importance of the scale of relationships during the arrangement progress like in natural formations. Within this framework, in order to simulate the organization of organisms as architectural spaces, two different strategies were used in different scales. In this study, considering these connections of living organisms, the emergence and organization of forms were practiced in different scales as uni-cell and multi-cell systems organization in architectural framework. In both examples, the formations of architectural forms were based on the characteristic relations and connections and distances of units.

4.2 Simulating Spaces as Uni-cell Organisms

In the first example, the organization of spatial units was simply constructed on the relativity of the units. This progress can be embodied as an organization of uni-cellular organisms in biology. Similar functions and forms create bounds to determine their neighbors. However, they do not create static forms. The replacement of the units will not affect the whole living form. Therefore, to define different relations of spaces with different functions, the connections of relative units were limited to distance between similar functions and degree of relativity.

The background of this example can be thought as placement of temporary living units such as emergence shelters. To adjust the order of chaotic organizations of living organisms, the relative families were arranged by their sizes, by the connections between units through specific order. Through this order, the organization can be manipulated to architecture in simpler way and will not be described as a random progress. Because, there is always an order behind the organization of living units mostly shapes in time and it is not easy to follow. For the design development, as an initial step, the physical features of design area were defined within several constraints such as max height, spatial boundaries, conserved areas etc… By some scripting, the outlines of the largest forms (common spaces) were placed by computer in design area with several possibilities (fig.3). Then, these possibilities were eliminated through the defined network values. In this case, the network values were described as distances of relationships. The use of networks helps to eliminate the best related units from numerous possibilities.

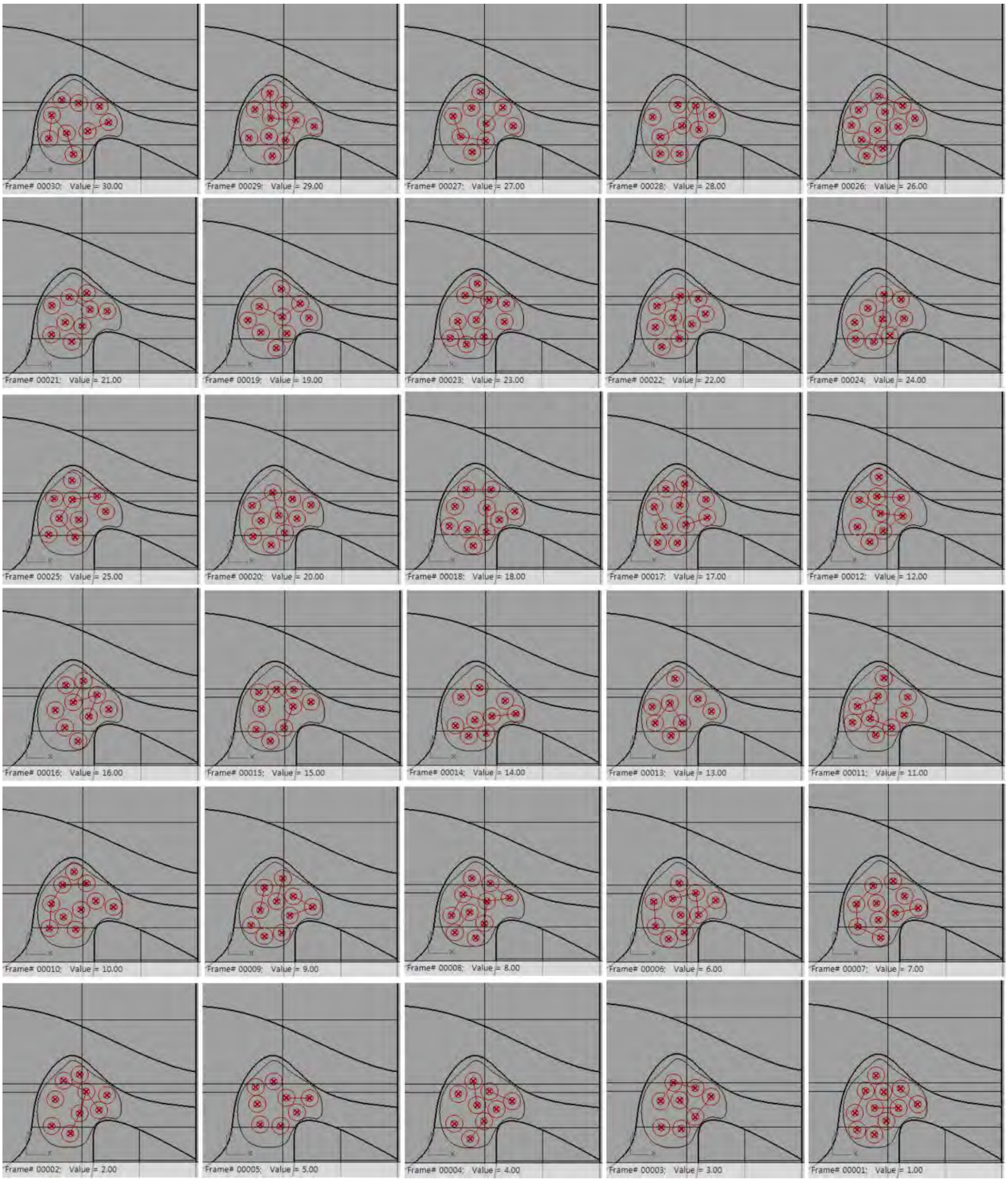

Fig.3 several possible arrangements of design units.

For the next step, the emergency shelters modular arrangements were located starting from the pre-defined common spaces to design boundaries by computer (fig.4). Finally, these shelters were connected through different lengths of network wires to eliminate the non-related (dead) units once more. The units with more than three wires were represented as families with children and others were described as two member families. The purpose of doing this is to create physical connections through social relationships of units in certain scale.

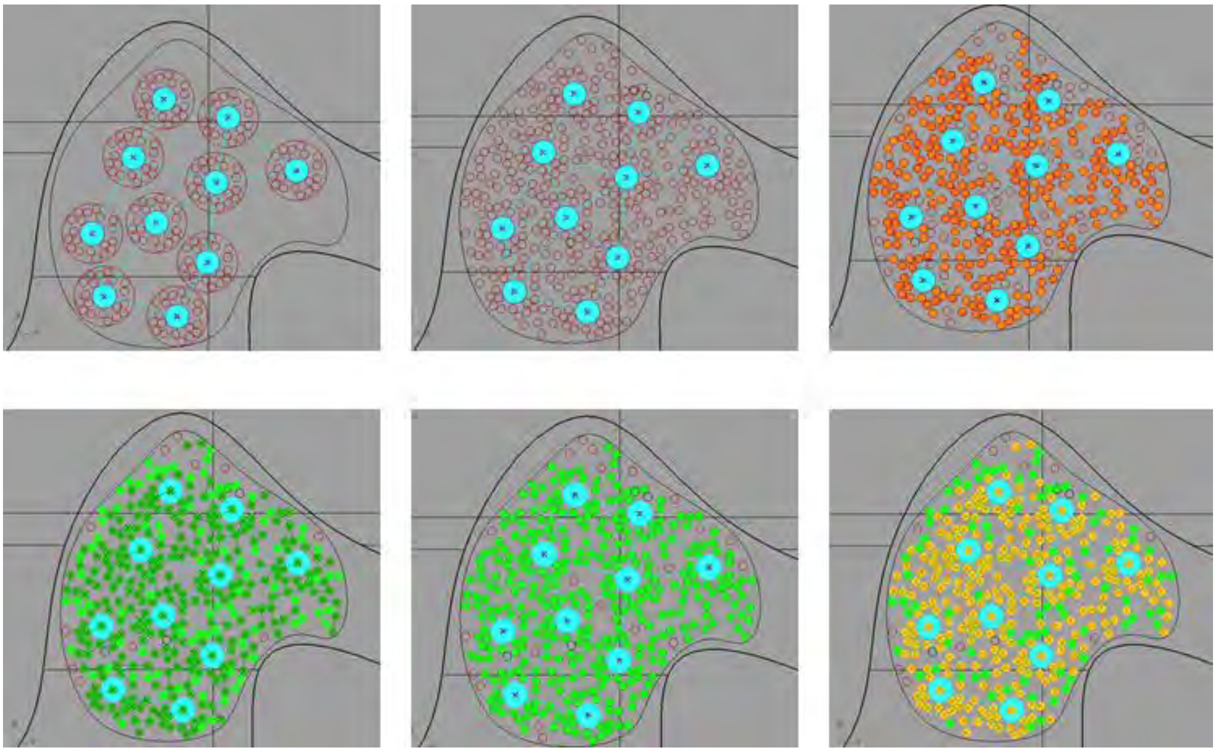

Fig.4 the stages of units' organization in functional order

As a conclusion of first example, the placement of units was generated through the neighborhood relationships. Within this strategy, the sustainability of social relationships can be provided by settling the similar families in specified points. Although there are numerous possibilities for placement emergence points of units, it is up to designer to pick one of them in the beginning and foresee the best efficient solution.

4.3 Simulating Spaces as Multi-cell Organisms

In the second trial, partially different strategy has been followed to create architectural forms with deeper complexity. In order to reduce the randomness placement of units and create the system works as whole, the organization of multi-cell organisms were adjusted as a design strategy. This time it is aimed to create more integrated spaces with different sizes contingent on their distance connections.

The background of the project was setup to create several units in different sizes, functions and distances. As a first step of this case, in order to grow the units in predefined spatial boundaries, several points were described with specified as cores of design units like in the first example. Once more, the network systems were used in specific orders to show the pre-defined invisible relationships of design cells (fig.5). Unlike the first example, the selection of living units were held in bigger pool in 3D frame and constrained by the volume requirements. Within the specific limitations, the end points of these network wires were grouped in 3D frames to support the relationship of similar functions (fig.6).

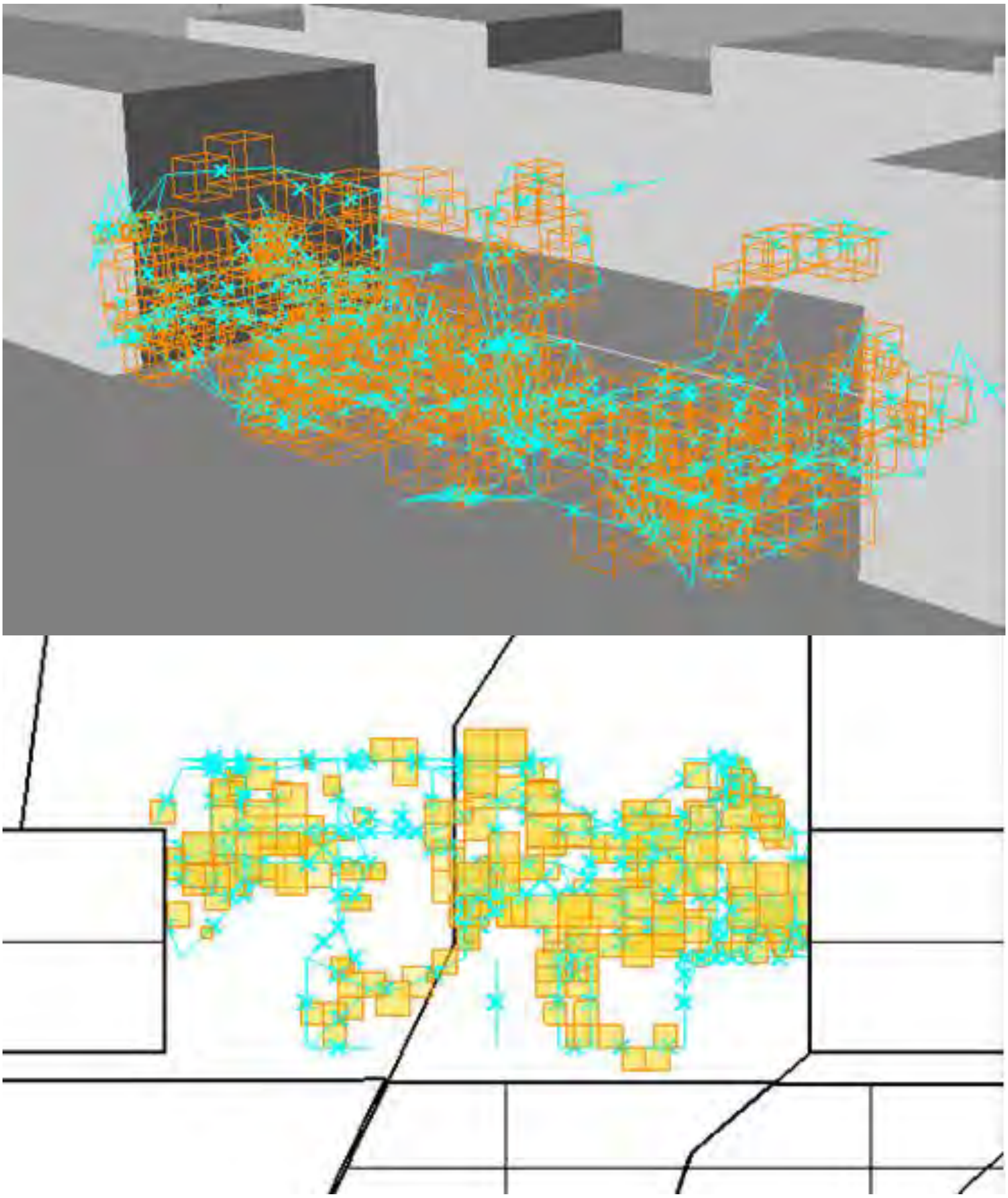

Fig. 5-6 the instant frame of the placement of relative spaces by network connections with specified parameters (volume and distance limits)

After grouping these space cores, the same strategy was applied for each function with different parameters (fig.7). Then, the frameworks of units were drawn to determine the growth of forms in 3d. With this strategy, the architectural spaces were placed in specific order and sized by their relations with other units. Then the groups were eliminated from (dead) non-related units and unwanted volumes by their defined constraints.

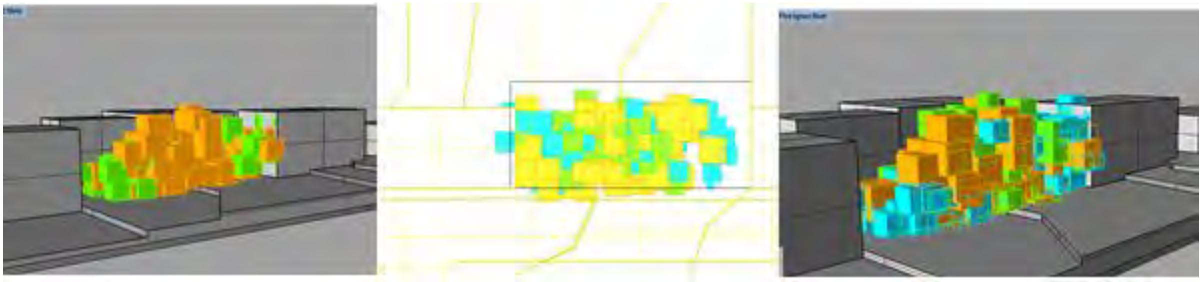

Fig 7 the placement of different space units through specified parameters

After calculating the efficient solutions (defined volume parameters by requirements for each) of each function and size, the instance forms were eliminated. By this procedure, the emergence point of each unit was positioned contingent on the other units and grew or died (disappeared) until reaching the defined requirements by designer with other related units of design.

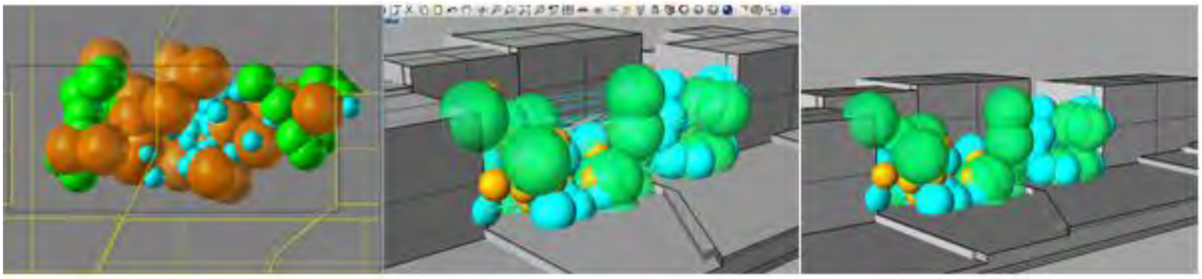

Fig.8 the several possibilities of architectural formations depending on specified parameters.

Conclusion

Although, several constraints were applied to manipulate the design progress, almost infinite possibilities can be generated by the nature's design logic. As reflections functional and social relationships between units, network systems, help to manipulate the complexity and chaotic order of design elements in architecture. By these invisible structures, morphological progress of design elements can be positioned in correlation with other members and particular order. Within this framework, the functional and social connections of design elements through their characteristics, helps to design many unique and efficient solutions. Revealing these connections and adapting them to requirements of physical values help to control the design development in a definite level.

The adjustments of morphological processes such as emergence, organization and natural selection into architecture, can help to design functionally efficient and more integrated heterogeneous spaces. Besides, through these approaches for design arrangements in architectural frame, nature can be measured in architecture not only as a dynamic form, but also as a mentality of the dynamic form.

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Images

Fig.1 http://www.dailygalaxy.com/my_weblog/2007/11/x-cells-five-su.html
Fig.2 http://www.dreamstime.com/stock-image-human-stomach-image2512651

Ferhan KIZILTEPE

Paper : **A BRIEF ESSAY ONTO JOEL- PETER WITKIN FROM SYMMETRY PERSPECTIVE**

Topic: Mathematics

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Abstract:
A glance at the issue of symmetry from outside a scientific perspective may help us understand the active role symmetry assumes in the associating art with science. In various fields and existing processes of art, it may be seen that symmetry and its associated concepts —both abstract and concrete— manifest themselves in different dimensions and geometries, with their fixed or loose characters. This may in general bring an explanation to the association of two things in terms of similarity or difference in a certain piece of artwork, and functions as some kind of a classification model. Accordingly, while taking a general approach to Joel-Peter Witkin and his works, is attempted to evaluate the mentioned concepts on the basis of such roles.
In the relationship between what Witkin thought/designed and the image he obtained (considering that no authoritative analysis may be made unless there is an explanation made by the artist on this and similar issues); we may speak of a symmetry as differences achieve an indiscernible level, of similarity when differences may be seen, and of dissymmetry when differences can be interpreted as variation. The relationship between the photographs of the living/non-living things used by the artist in his compositions and their originals may be viewed within this framework.
The concept of invers symmetry draws attention in terms of the roles it assumes in the photographs by Joel-Peter Witkin. The artist underlines this approach even more powerfully in his still life and portrait works. Images portrayed as living in still life and portrait paintings continue with their lives while in Witkin's photographs, they seem to continue to live in a period of recovery with their dead state. Therefore, death (cadaver) may be interpreted as a transformative mechanism where symmetry takes shape as it helps reach the desired meaning.

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Keywords:
Symmetry, Joel- Peter Witkin, Automorphic, Similarity, Asymmetry, Invers Symmetry, Image, photograph.

A Brief Essay onto Joel- Peter Witkin from Symmetry Perspective

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Abstract

"If I am not mistaken the word symmetry is used in our everyday language in two meaning. In the one sense symmetric means something like well- proportioned, well-balanced, and symmetry denotes that sort of concordance of several parts by which they integrate into a whole. Beauty is bound up with symmetry." [6] or "An expression of equivalence between things" [7].

The quotes above present us with two fine examples of how the concept of symmetry could be defined in contemporary language and theory. By employing a more mathematical approach to the same concept, another definition may also be made, as "it is the inalterability of an object, a set or a system in the face of a transition". This explanation also helps us see that a set is not necessarily always inalterable under a transformation and that in addition to symmetry, other concepts including equality, equivalence, similarity, proportion and balance may also be relevant. Here; while invoking mathematical expressions such as symmetry leaving its place to similarity in its transition from Euclidean geometry to non-Euclidean geometry or the ornamental and crystallographic symmetry, which are the two geometric symmetries with highly symmetrical characteristics; the above-mentioned expressions should not be taken as relevant solely in mathematical terms.

A glance at the issue of symmetry from outside a scientific perspective may help us understand the active role symmetry assumes in the associating art with science. In various fields and existing processes of art, it may be seen that symmetry and its associated concepts —both abstract and concrete— manifest themselves in different dimensions and geometries, with their fixed or loose characters. This may in general bring an explanation to the association of two things in terms of similarity or difference in a certain piece of artwork, and functions as some kind of a classification model. Accordingly, while taking a general approach to Joel-Peter Witkin and his works, this article attempts to evaluate the mentioned concepts on the basis of such roles.

1. Image and Photos

It is obvious that one may draw a general analogy between the biological act of seeing and the language chosen by the beholder and technological imaging mechanisms used in an appropriate technology. It may also be argued that symmetry occurs not only in the presence of equivalence and similarity but also when the differences are at an unperceivable level in the relationship between the aforementioned actions. And in such a case, seeing an object and viewing it with the use of an imaging tool may be interpreted as processes in which mechanisms of high similarity and symmetry are at work.

From left to right: Bursa- Türkiye. Photographer: Refik Kızıltepe.

Throughout history, scientific, technological and digital developments as well as their subsequent impacts on human life demonstrate that image takes part in art as a tool. In this process, the image produces its unique principles and terminology, which arises as a natural consequence of this situation. At this point, it will be appropriate to briefly tackle how to define image in art from the perspective of the examination.

From left to right: Karadeniz, Bursa- Türkiye. Photographer: Refik Kızıltepe.

Defining image in art as a main tool as a manoeuvre within time and space by Richard Leppert who also indicates that the image is a diagnosis, prediction and validation mechanism [1]. Thanks to the advances over the last century, and particularly its latter half, one can speak of a partial transformation undergone by the concept of image due to dynamics including reality/virtual reality, production/consumption cycle, recording/reproduction. As a result of such changes, one may argue, the act of visualization has evolved through the use of imaging tools such as camcorders, analogue/digital cameras.

While images obtained by means of various recording tools such as camcorders and cameras are called technical images, the acquired images form a unique category inter se. Particularly photos obtained through the camera may be described as technical images that directly convey the thoughts/ideas of the photographer, providing for the representation of millions of images. Furthermore, photography, which has retained its overall structure within the existing developmental processes, could be said to have assumed a leading role in the changing understanding of image of the society. Therefore, it could be assumed, as also noted by Graham Clarke, the developments since the middle of the last century have carried photography to a privileged area that has been much more in demand and recognized than its predecessors.

From left to right: Bursa- Türkiye. Photographer: Refik Kızıltepe.

2. Joel- Peter Witkin and Symmetry

Capturing the moment and space in the flow of time, a photograph comes into existence based on light and darkness. Noting that the shadow factor was added to this duo by T.S. Eliot, Clarke compares photography, which he describes as a mirror reflection where images of the perceived world are at the forefront, to leaving one's signature on the same world in a script of light [2]. And when we view the world of photography through this metaphor, Joel-Peter Witkin's signature can be seen to have a prominent place.

Expressing his view of life with the lines "Between the advent of pain / which is Birth, and apotheosis / which is Death, there's convalescence / which is Life." [3], Witkin is an artist who photographed the world he sees with his extraordinary perception. Witkin did his military service in Vietnam as a war photographer, and a traffic accident he witnessed at a very young age is known to have played a large role in the development of his extraordinary perception [4]. The artist, who was reportedly influenced by photographers such as Diane Arbus and Arthur Felling, significantly differs from them as he addresses similar issues at the extremes through art and photography. With a great sense of humor, the artist wanders on the aesthetics of the evil, ugly, rejected, and dark side, and while ensuring that his photographs are seen as harmonious and flexible, he always maintains his tenderness also in his relationship with the body and spirit. Noting that everything in his works, good or bad, represents him, Witkin compares the unification of the eye with the viewfinder to the unification of body and soul [5] This relationship established by Witkin reminds the audience of Dziga Vertov.

As a photographer that has questioned and transformed art history, Witkin carefully takes Rubens, d'Agoty, Delacroix, Ruysch, Gericault, Goya, Velasquez and similar artists as a reference while maximizing his own freedom. Resembling Peter Greenaway in his blending of technical images with art and the relationship he established with classical art history, the artist has a symbolic language like Greenaway. The images Witkin extracted from of the dark side reminds the audience of Bosch paintings, while they are also associated with artists such as Allen Poe, Baudelaire, de Sade, and their works.


From left to right: Woman Once a Bird, 1990 [4]. Melvin Burkhart Human Oddity, 1985, Thames& Hudson Ltd.

When a picture taken by the artist comes to daylight as a Witkin photograph as a result of his meticulous work in his dark room, it may be argued that they are highly similar only with each other as they are unique in the art of photography. The resulting photograph may be interpreted as symmetrical to itself under a one-to-one and onto transformation that maintains the existing structure (in the event that differences are at an indistinguishable level). In other words, that photo may be said to be automorphic.

In the relationship between what Witkin thought/designed and the image he obtained (considering that no authoritative analysis may be made unless there is an explanation made by the artist on this and similar issues); we may speak of a symmetry as differences achieve an indiscernible level, of similarity when differences may be seen, and of asymmetry when differences can be interpreted as variation. The relationship between the photographs of the living/non-living things used by the artist in his compositions and their originals may be viewed within this framework. For example, anyone who sees his work, titled the "Feast of Fools-1990," will obviously not confuse the grapes used here with any other fruit. Therefore, an equivalence relation may be established in terms of meaning between the grapes on the photograph and actual grapes. This equivalence relation may be interpreted as a symmetric (Topologically Homeomorphic) match in terms of meaning. In addition, when we examine it looking at basic elements such as the sizes and colors of displayed grapes, it can be said that real grapes indicate a class in themselves. On the other hand, there is a formally symmetrical relationship between the image covered by the angle of the lens and the image of the developed film (in those cases where differences are indiscernible) and an anti-symmetric relationship in terms of values it contains such as color and brightness. A similar assessment may be made for the existing relationship between the film’s negative and print. Here, considering Witkin’s unique printing process, there may obviously only be a similarity in the relationship between the film's negative and print. Furthermore, unless there is a change of measure between the reproduced photographs, we may speak of symmetry, a similarity resulting from scaling-contraction in small-sized prints, and from scaling-homothetic transformation in large-sized prints.


From left to right: Still Life, Marseilles,1992 [5]. Anna Akhmatova, 2003, Thames& Hudson Ltd.

Overall, the concept of invers symmetry draws attention in terms of the roles it assumes in the photographs by Joel-Peter Witkin. The artist reinterprets artworks such as Botticelli’s 'The Birth of Venus' and Diego Velazquez's 'Las Meninas', through a different expressive tool by reversing their inherent abstract and concrete elements. The artist underlines this approach even more powerfully in his still life and portrait works. The portrayed game animals depict values such as power and aristocracy while they are ugly carcasses with Witkin. Classic portraits often depicted people at an ideal level, more beautifully and with their human feelings obscured. People in such portrait paintings come from wealthy upper class families. This and similar values are completely reversed with Witkin; mathematically speaking, their inverse symmetry is taken. Images portrayed as living in still life and portrait paintings continue with their lives while in Witkin's photographs, they seem to continue to live in a period of recovery with their dead state. Therefore, death (cadaver) may be interpreted as a transformative mechanism where symmetry takes shape as it helps reach the desired meaning.

Finally, in Witkin's photographs, beautiful is frequently replaces by ugly, male/female with hermaphrodite, healthy with unhealthy, complete with incomplete, living with the dead. While such contradictions may be inverse symmetrical in terms of the value they contain, depending on the content of the works, this approach may be taken as helping reach the same meaning from opposite directions. Therefore, when we tackle such contrasts in terms of meaning, they may be interpreted as a transformative mechanism that carries scenes into a symmetrical image as a result.


From left to right: Las Meninas, 1987 [5]. Gods of Earth and Heaven, 1988 [5].

3. Conclusion

Briefly discussed within the boundaries of this article, Joel-Peter Witkin and his works are the last ring in the attempts to approach the domain of art from a mathematical framework. Findings similar to those obtained in studies on the 15th & 16th century Ottoman Iznik tiles / Ottoman architecture, M.C. Escher's works, Peter Greenaway films, or Frank O. Gehry's architecture, which were also carried out with a mathematical perspective, are observed in the early results of the Witkin study tackled here. And the concept of symmetry seems to bring two fields, which at first glance, are thought to bear no relationship, in an unexpected order, appearing before us as a significant element in this approach attempt as well. In general, the findings reached in these demurely conducted studies confirm the existence of symmetry and its associated concepts in the field of art. Consequently, we believe that a review of these concepts, which are studied actively in physical sciences, in terms of their forms of expression, structures and relationships in the field of art may make various contributions in the field.

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Visualisation of Archaeological Data Using Voronoi Diagrams

Topic: Architecture

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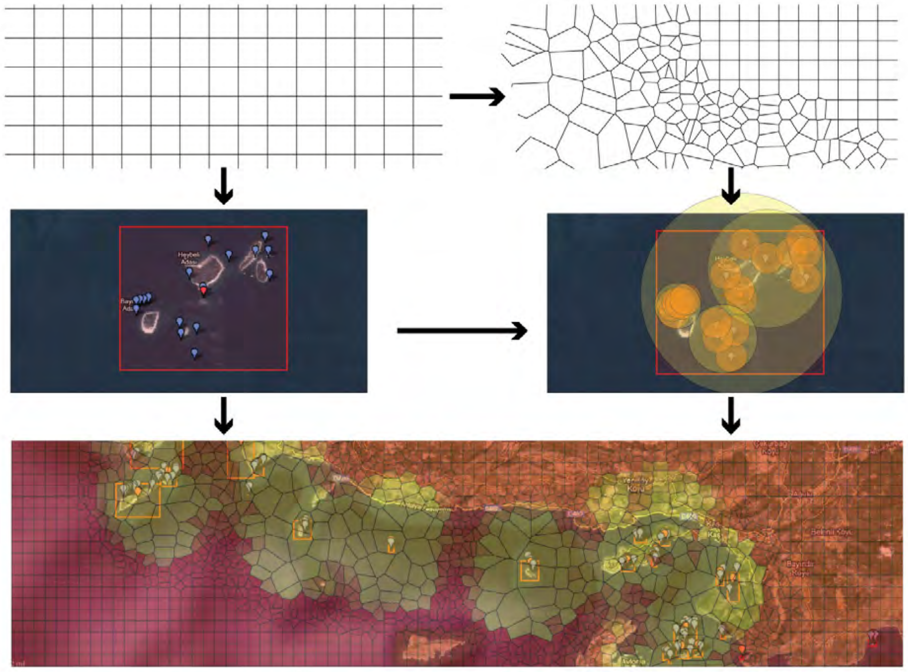
Abstract:
The widespread usage of computers brought new challenges into the design, production and external representation of data with generative approaches. Within the last few years, generative methods have gained attention especially in the context of cultural heritage. As generative model describes a rather ideal object than a real one, generative methods are a basis for visualisation of archaeological data. In order to make archaeological data accessible to cultural heritage experts and to the general public, we created generative geospatial maps which accounts for the dissemination of data through online systems. The result is a generative voronoi diagram based on Grasshopper plug-in and Rhinoceros software.

In this study, an alternative approach on the external representation of archaeological data has been put forward by using voronoi diagrams as an interface. These diagrams are spatial decomposition of a given space, determined by distances to a specified family of objects. Thus, they enable the division of such multi-dimensional spaces into subspaces. This presented external representation approach is based on deformation of the point cloud formed. Within the constraints of the data gathered, the point cloud is deformed according to the number of findings in the each region. On the next stage, the point cloud is turned into voronoi diagram to highlight the density of archaeological data based on the geographical distribution, and it helps to externalise the relationship between different regions around the coastal line.



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Keywords:
Voronoi diagrams, archaeological data visualization, generative design

Visualisation of Archaeological Data Using Voronoi Diagrams

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Abstract

The widespread usage of computers brought new challenges into the design, production and external representation of data with generative approaches. Within the last few years, generative methods have gained attention especially in the context of cultural heritage. As generative model describes a rather ideal object than a real one, generative methods are a basis for visualisation of archaeological data. In order to make archaeological data accessible to cultural heritage experts and to the general public, we created generative geospatial maps which accounts for the visualisation of data through online systems. In this study, the voronoi polygons are drawn onto Google Maps while the geospatial data is processed in Javascript using generative voronoi diagrams.

An alternative approach on the external representation of archaeological data has been put forward by using voronoi diagrams as an interface. These diagrams are spatial decomposition of a given space, determined by distances to a specified family of objects. Thus, they enable the division of such multi-dimensional spaces into subspaces. This external representation approach is based on deformation of the point cloud formed. Within the constraints of the data gathered, the point cloud is visualised according to the number of archaeological finds in each site. On the next stage, the point cloud is turned into voronoi diagram to highlight the density of archaeological data based on the geographical distribution, and it helps to externalise the relationship between different sites around the coastal line.

Introduction

Data visualisation is the study of visual representation of data, for communicating information clearly and effectively. The conventional ways to visualise data such as tables, histograms, pie charts and bar graphs are widely used in many fields [1]. In the field of archaeology, visualisation is used as a tool for analysis of data to convey the interpreted meanings. As a visualisation tool, allowing archaeologists to visualise the above ground appearance of sites out of the information gathered from the foundations, the earliest 3D models were aiming to replace the paper model equivalent of the illustrations made by a talented hand. However, the potentialities of the digital technologies are far exceeded just to copy the talented hand. Digital technologies became a tool for the analysis, visualisation and dissemination of data at various stages of the archaeological interpretations.

In this project, generative methods are applied to display the data collected and stored in a web-based information system developed for a model of online system using the data collected during underwater surveys conducted on the coastal region of Lycia, Turkey. The system currently contains information on c.700 finds in the form of sketches, measurements, drawings, photographs of finds. Combined with Google Maps, this database illustrates the initial technological steps towards the development of an online system for the display of large data sets in interactive maps. Related to this information system designed and developed using the Wamp software bundle, the geospatial data is processed in order to visualise the archaeological finds at a specific site. The data is extracted from the MySQL database using PHP language. Further processing, clustering and visualising of the data are completed using JavaScript language. The result is a visual tool that is displayed as voronoi diagrams and linked to interactive maps in a hierarchical format.

Literature Review

The visualisation of archaeological information is one of the most attractive ways in which computer technology can be employed in archaeology. The term visualisation includes almost any exploration and reproduction of data by graphical means. In his overview of computer applications in archaeology, Richards argues, that these exploration techniques allow “visual interpretation of data through representation, modelling, and display of solids, surfaces, properties, or animations” [2]. Thus, computer applications in archaeology refer mostly to the 3D modelling of the sites in order to display the interpretation of archaeologists. Moreover, 3D models can now serve as research tools to interpret various kinds of data [3]. However, it is often criticised that nowadays 3D models lack archaeological complexity. In other words, these models are blank, that is, they only serve as visualisation tools but do not provide any further information. The current techniques of surveying such as photogrammetry and laser scanning offer numerous methods for the insertion of the complexity lost during the creation of digital models. Acknowledging these methods, we offer a special approach to detach the link between archaeological data and representation of reality in 3D format.

Visualising is a tool to understand and represent reality. The idea here is not only the representation of archaeological data, but also to retrieve data out of the archaeological object. In a way, visualising is a tool for archaeologists to solidify the information. Alternatively, visualising is a tool for users to experience the environment virtually. Whether it is composed of the computer reconstructions of the objects and of the photographic realities of panoramic immersion, virtual environment empowers the visualising process. As Barceló states, future advancement of virtuality techniques should not be restricted to “presentation” techniques but to explanatory tools [4].

Voronoi diagram is a mathematical tool applied across many scientific disciplines. It shows boundaries between neighbours. Similarly, voronoi polygons are polygons whose boundaries define the area that is closest to each point relative to all other points. Voronoi diagrams and polygons are applied to various academic fields from music to architecture. However, voronoi diagrams have little application examples in the digital heritage domain. A specific example that is closely associated with the subject of this paper is the example by Delort. He presents an approach for visualising large data sets in an interactive map [5]. His technique retains hierarchical relationships between data items at different scales.

Leaving aside the complex systems of 3D dimensional environment, we propose the geospatial display of the archaeological data as explanatory tool. The generative methods of data display are linked to the information system for creating interactive geospatial maps. The information system accommodates the complex nature and extensive amount of archaeological data collected for the dissertation project of Varinlioglu [6]. For this purpose, a prototype has been implemented and tested showing the effectiveness of the method for visualising large data sets using voronoi diagrams.

Web-based Information System for the Virtual Museum

This online information system for systemic data collection, description, and interpretation, currently contains information on 22 geographically distributed archaeological sites. Combined with the GPS locations of sites and findspots, the result of integration of the database with Google Maps illustrates the distribution of sites along the Lycian shoreline of Turkey. Essentially an online database for systemic data collection, description, and interpretation, the system currently contains information on c. 700 finds through sketches, measurements, drawings, and photographic entries of individual archaeological finds, in addition to regional descriptions and observations made by divers.

The information system has been developed with a web-based, client-server architecture. All data storage is done on the server side, while data input and display are done on the client side. The server application works on a web server and is supported by a relational database management system (RDBMS) and the native file system for data storage and retrieval. The client application works on web browsers and communicates with the server application synchronously and asynchronously through the Internet. Using the AMP software bundle, the information system is a platform free, web-based information system, which works on the Apache server, stores its data on MySQL database system and is programmed using PHP scripting language.

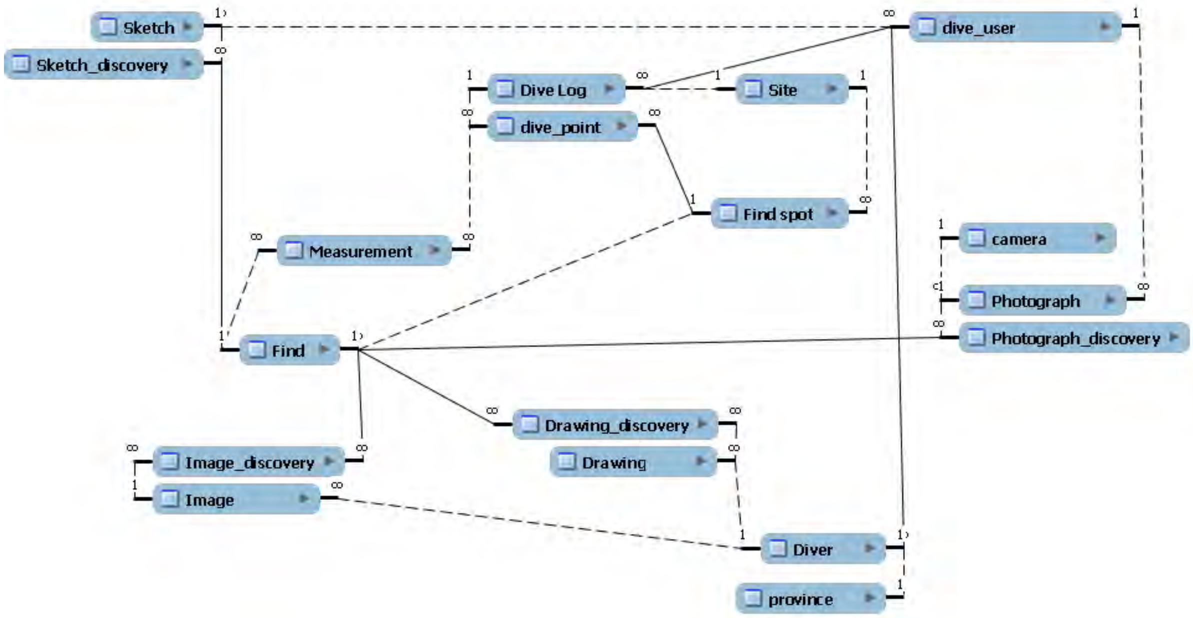

Figure 1 Diagram of the database structure

The information system was composed of major components that are self-competent information systems on specific topics, which are closely linked to each other. Each component covers several record types and includes all data entry interfaces and database queries. These components were categorized as dive-logs including researchers/divers, sites, findspots, find logs including measurements, photographs, sketches, and analysis/visual media such as drawings, images, notes (Fig.1). Dive logs together with findlogs recorded during field surveys are listed with location information of the geographically distributed regions, named as sites. The Situated within the geographical boundaries of the sites, the findspots are defined by geographical coordinates and bearings. At these spots, the finds are logged into the database with measurements, photographs and sketches. For displaying the mapping data, an external Internet Map Server is used.

The mapping component was primarily used for findspot, site and dive log components for the designation of geographical locations of finds, the extents of dives and sites. The locations of findspots were marked as single points, the sites as rectangular areas, and the dives as two points defining a straight line. Mapping tools were available for expanding, contracting, zooming and removing rectangular areas. As maps are updated automatically by Google, the coordinates of the entered locations were displayed on the updated map automatically (Fig. 2). To facilitate the entry of coordinate information, the mapping component allowed coordinates to be entered as various formats. The format of the coordinates was automatically determined by the system and converted into decimal degrees during data storage. Latitude and longitude of the marked location were indicated on the corresponding data form elements.

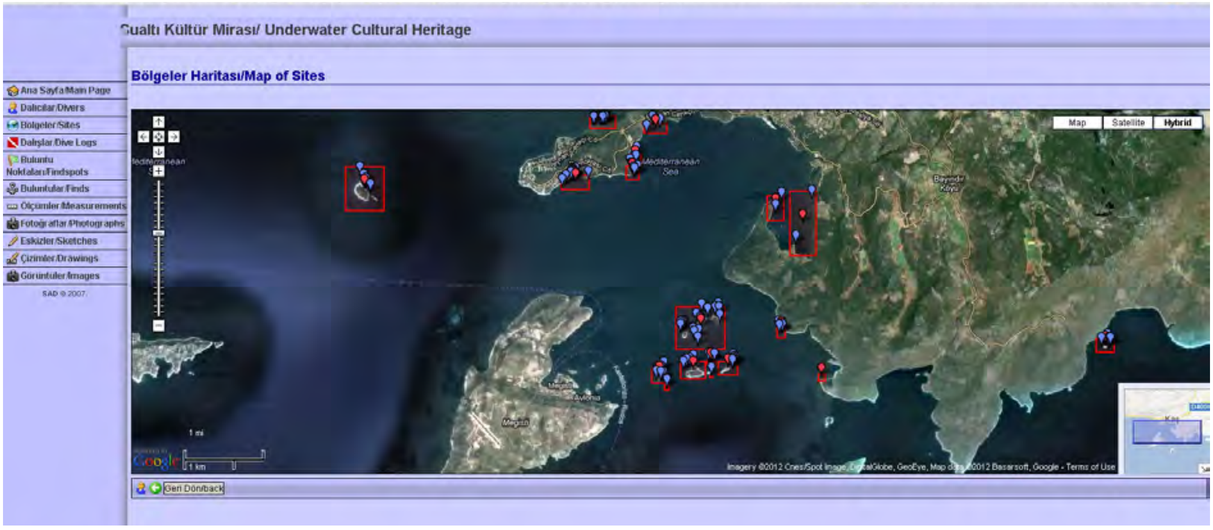

Figure 2 Interface of the information system designed for the virtual museum.

The component was linked to findspots for displaying the distribution maps of finds and to dive logs to keep track of the area covered during the surveys. The information system has built-in lists of sites with data on their geographic boundaries. Once a site is selected, boundary information is retrieved from the server and the extents of the map are updated to display the selected site. In order to increase ease of use, a custom windowing interface was developed, which allowed map display having a fixed dimension and position on the page to be undocked from its location and resized freely. Ability to enlarge map display size without affecting other data entry elements greatly enhanced the friendliness of the mapping component and facilitated marking on the map.

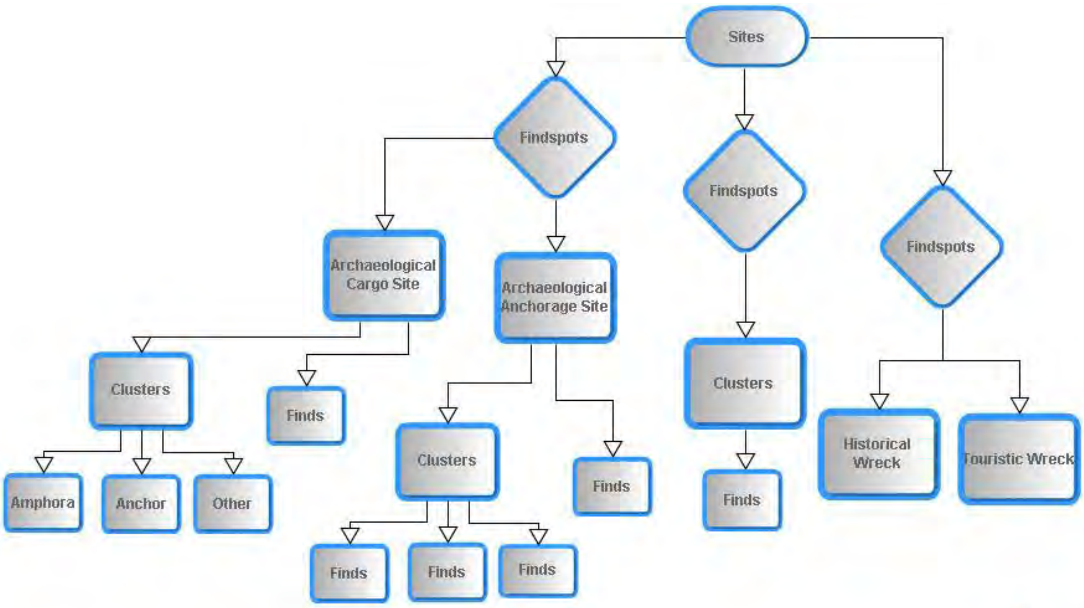

Figure 3 Hierarchical tree-map of the archaeological finds

The interface of the information system displays the sites and the related findspots on the same Google maps image. Unless an interaction occurs such as zooming of clicking on the findspots, the overlapping tags create clutters for the user. To eliminate clutters, the findspots are only displayed as blank spots. In other word, the properties of the findspots, such as the number and type of the find linked to that findspots are not displayed in this model. As displayed in Fig. 3 the clustering archaeological finds of a site forms a tree-map hierarchy. An archaeological site contains numerous spots related to finds. Each find type, whether a single amphora or a whole wreck site, has location information.

Problem Definition

The geospatial data is displayed through tags of findspots on the Google Maps. However, this display is rather confusing as the tags give no clue about the classification of the finds related to these findspots. Moreover, the quantity of the finds related to the findspots is not displayed in these tags. In other words, the visualisation through standard Google Maps tags is insufficient for both the users to understand and interact within this virtual environment and for archaeologists to make relevant analysis out of this data. In order to avoid any clutter/noise in the display of these geospatial maps, we proposed a generative method for the display of geospatial data.

Proposed Approach

Our method for visualising the archaeological data is threefold. First, the geographically distributed archaeological spots are clustered with respect to their distance on the map. Named as sites, these clusters gather all the finds in one geographical spot. Then, the spots closely placed to each other at a given scale cause clutter in the display. These clutters, overlapping and confusing display of data, prevent the users differentiating the findspots and the related information. To avoid this distraction, clusters of findspots are hierarchically organized and displayed. Finally, these clusters are represented on a map by voronoi polygons. According to the density of finds at a chosen spot, the voronoi diagrams are generated with color densities representing the find numbers (Fig. 4).

The first step is to retrieve the information from the database. As the information system is designed and coded in the WAMP software bundle, the queries from the MySQL database are coded in PHP language. In these queries, the main reason was to retrieve the geospatial coordinates, latitudes and longitudes of findspots and the number and type of archaeological finds at each findspot. This data is collected into a comma separated value (csv) data format and passed into to the JavaScript program which handles the clustering and the visualiation. Csv format is preferred as it was easy to parse the information in the program.

The second step is to prepare clusters of finds so that no clutter appears on the screen of users. Delort [5] mentions the difficulty of measuring clutter because it is task and device dependent and also subjective. For example, a desktop machine with huge screen can display the points on map with a lot of distance between them, but the same map may appear on a mobile phone with points on top of each other. To control the clutter finds that are located in the same spot are joined into clusters. But this is not enough as the clusters may be located in a distance that is too small to separate the two points in the map screen for the selected zoom level. Therefore the distances between each cluster or find is calculated and stored in a distance matrix. From this matrix, starting from the lowest distances the finds are added to the clusters. The newly constructed clusters appear in between the original points proportional to the amount of finds in the spot which makes the process weighted. This process continues until the distances between clusters or points become larger than a selected minimum threshold value.

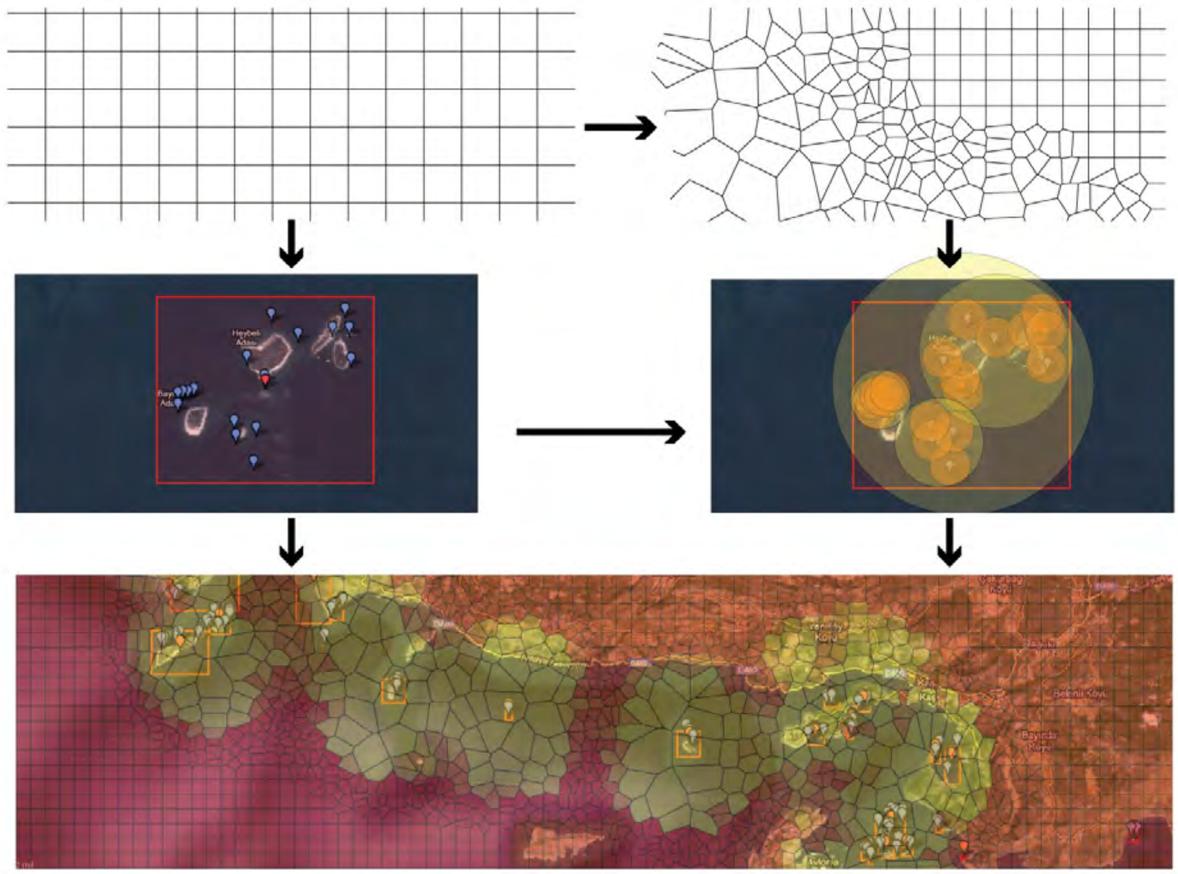

Figure 4 Voronoi diagrams for the visualisation of geospatial maps

After clusters are joined, voronoi diagram of the area is drawn so that the centroids of the voronoi are located on the points of the clusters. Voronoi diagram is chosen for the representation of the density of the finds as it allows a generative way to visualise find density in one place. Moreover, the voronoi polygons are highlighted with different colours representing the amount of finds in the area. When the user clicks the polygon, a popup box outputs the number and type of the finds founded in the area. The finds are represented with the icons of the finds.

If the user changes the zoom level, that is if the user zooms in or out from the current view the clusters are recalculated. The minimum accepted values for distance between finds are decided for each zoom level and in every zoom level change. The clusters are shown in a way that they are within those minimum values.

Conclusion

The information system has been developed with the objectives of preservation of the data gathered during field surveys, accessibility by the interested parties, the integration of multi-aspects of archaeological research under a single roof, and user-friendliness for the users. As the system was not limited to any site, the user can do different kinds of spatiotemporal searches on the data, especially on Google Maps.

Related and linked to this database system, we presented a technique for visualising clusters of spatial data in interactive maps. The technique retains hierarchical relationships between data items at different scales. Using the voronoi polygons, the geospatial information is conducted to the users of the system. This visualisation method offers new ways to display the archaeological data.

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Igor Peteh

Paper (Artworks): **THE ART OF TRANSCRIPTION**

Drawing by Ivan Branko Imrović

Topic: Music

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Abstract:
The word composing etymologically comes from the Greek word synthesis and a Latin synonym which corresponds to a term compositio. Transcription of music work is an adaptation of the music work in other media or other musical instrument, by the procedure which not profanes its essence, its idea. Less intervention in musical substance means more successful transcription. *Conditio sine qua non* of transcription is directly conveying the original message and the power of expression. Incentive for processing comes from the original and ingenious musical ideas that can be used in other media. The art of transcription is a matter of good knowledge the musical style and good knowledge of the possibilities of instruments or voices. Sincere admiration to the original art work procreates the true artistic need to participate in the re-creation of a pre-existing art work. Organum is the oldest type of music which began the art of transcription. From the famous transcriptions should be mention La Bataille de Marignan by Clement Janequin, Bach's organ and orchestral works, songs by Franz Schubert and many other works until today. The whole history of transcription embodies continuously striving to transform an idea into its image and to give it a new life. Massenet's Meditation from the opera Thais is a masterpiece. It is harmonically rich, emotionally-charged and compositional clear. From the time of its creation Massenet's Meditation continuously preoccupied attention of musical interpreters and listeners. Therefore it becomes for a long time a global classic evergreen. Sophisticated harmonic progressions, intriguing atmosphere and a wide range of expression, induced me to transcribe this composition for piano. Piano is a universal instrument, it has a long time been confirmed as the main instrument for transcription in a music history. Because of all of these mentioned above, I had the need to become a part of this music.

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Keywords:
Transcription of a music work, composing, instrument for transcription

The Art of Transcription

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Premise

The word composing etymologically comes from the Greek word synthesis and a Latin synonym which corresponds to a term "*compositio*". Transcription of music work is an adaptation of the music work in other media or other musical instrument, by the procedure which not profanes its essence, its idea. Less intervention in musical substance means more successful transcription. *Conditio sine qua non* of transcription is directly conveying the original message and the power of expression. Incentive for processing comes from the original and ingenious musical ideas that can be used in other media. The art of transcription is a matter of good knowledge the musical style and good knowledge of the possibilities of instruments or voices. Sincere admiration to the original art work procreates the true artistic need to participate in the re-creation of a pre-existing art work. Organum is the oldest type of music which began the art of transcription. From the famous transcriptions should be mention *La Bataille de Marignan* by Clement Janequin, Bach's organ and orchestral works, songs by Franz Schubert and many other works until today. The whole history of transcription embodies continuously striving to transform an idea into its image and to give it a new life.

Jules Massenet – Thais Meditation

Jules Massenet (1842. – 1912.) was born in Montaud, France. At the age of 10, he was admitted to the Paris Conservatory. In 1863 Massenet won the Prix de Rome, a prize which allowed him to travel and study in Italy and began to compose in earnest.

Massenet is well known with the operas and the solo violin Meditation from Thais. During his lifetime Massenet was one of the most celebrated opera composers. His gift for melody and harmony is reflected in first line in his operas, but also in other kind of music he composed. (vocal music, chamber music, piano pieces etc.).

Massenet's Meditation from the opera Thais is a masterpiece. It is harmonically rich, emotionally-charged and compositional clear. From the time of its creation Massenet's Meditation continuously preoccupied attention of musical interpreters and listeners.

Therefore, it becomes for a long time a global classic evergreen. Sophisticated harmonic progressions, intriguing atmosphere and a wide range of expression, induced me to transcribe this composition for piano because a piano is a universal instrument. It has a long time been confirmed as the main instrument for transcription in a music history. Because of all of these mentioned above, I had the need to

become a part of this music.
Next pages represent my original transcription of Thais Meditation by Jules Massenet as my original work and they are following:

TRANSCRIPTION BY IGOR PETEH

2/5

TRANCRIPTION BY IGOR PETEH

3/5


37
4/5
40
44
48
51
BRUNNEN
TRANCRIPTION BY IGOR PETEH
4/5

Acknowledge

The author thanks prof. Celestino Soddu for invitation and the opportunity to incorporate my work on transcription for a piano solo of *Thais Meditation* by Jules Massenet within the *15h Generative Art Conference GA2012.*

COURCHIA Jean-Paul

The unit of vision: the concept of *opsieme*

Topic: art and science

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Originating from the embryological neuroectoderm layer, the retina acts like a real extension of the central nervous system (1), selecting and processing information that it will later transmit to the cerebral cortex. The eye centers the fovea, (1.5 mm diameter in the retina), on a desired and specific target. The fovea is exclusively composed of cones, which makes it the region of the eye with maximum acuity. This way the eye achieves a fixation (200-300 ms). Then the eye displaces the fovea to another target, thereby completing what is called a saccade. At a normal reading pace, one perceives 3-4 letters to the left side and 7-8 letters to the right side of the eye's anchor point (2). According to cognitive neuroscientist S. Dehaene (3), recognizing letters and their combinations (graphemes) and then creating an interface between what's written and what's articulated (phonological awareness) is the way to gain access to the lexicon that we use to communicate. If we indeed pay attention to the basic elements that compose the written sentence, we find letters, syllables and words. However, the smallest significant element of the sentence is probably the grapheme, since the whole understanding process derives from it. The grapheme is the written equivalent of the oral phoneme. It is comprised of the smallest group of letters making a phoneme. Does this same concept apply to a painting ? Just like in the reading process, the image undergoes several mutations between the retina and the sensory areas of the cerebral cortex, whereby the basic components of the image (forms, colors, orientation of the lines) are dissected first and then transmitted to the visual areas. Dismantling, reassembly and identification are the three steps in the process of the visual representation, whether artistic or natural. The time spent in front of a work of art is known to be very short (10-45 sec); the spectator leaving the art piece stores in his neurons a permanent image made of sharp zones and less sharp ones. It is based on these foveal and peri-foveal elements solely that the spectator will understand the meaning of the message that the artist wants to convey, not only at a purely semantic level, but also at an esthetic and emotional level. Thus the reading of a sentence and the « reading » of an art piece seem to be similar processes. We would thus like to equate visual units and graphemes. This basic element can be explicit, but still has a polysemantic potential at this stage. It must be linked to other basic elements or visual units in order for the image or the art to be understood as a whole and make « one » sense only. We suggest opsieme as a designation for the smallest significant visual unit: « opsie » – from the Greek ops, opsis, which means eye, vision and « eme », suffix which signifies basic unit. The education of the eye movements evolves, according to the substrata that are presented to us. The classic or figurative painting, is read as we read in a book and the modern painting is read in the style of our information's researches on the Internet?

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Keywords: eye movement, brain, neuronal recycling, perception.

The unit of vision : the concept of *opsieme*

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Thanks to vision, one can discover and relate to one's surrounding world. The eye is much more than a simple photographic tool which gathers information in order to present it to the brain. Originating from the embryological neuroectoderm layer, the retina acts like a real extension of the central nervous system (1), selecting and processing information that it will later transmit to the cerebral cortex. The study of ocular movements helps us understand how the eye indeed analyzes the surrounding world. The first principle is that visual acuity is not homogeneous in the visual field. First, the eye centers the fovea, a tiny dimple of 1.5 mm diameter in the retina, on a desired and specific target. The fovea is exclusively composed of cones, which makes it the region of the eye with maximum acuity. This way the eye achieves a fixation ; with each fixation usually lasting between 200 and 300 ms. Then the eye displaces the fovea to another target, thereby completing what is called a saccade. Vision is thus a succession of fixations and saccades, rather than a single global input. If only foveal vision can generate a sharp vision, the peri-foveal vision is indeed blurred. That is, when one reads a written page, only certain letters are simultaneously perceived acutely, while the rest of the page is blurred (2). At a normal reading pace, one perceives 3-4 letters to the left side and 7-8 letters to the right side of the eye's anchor point (3). Thus, reading consists in fixating onto micro-areas of only a few letters length in the midst of a multitude of letters. According to cognitive neuroscientist Stanislas Dehaene (4), recognizing letters and their combinations -- called graphemes -- and then creating an interface between what's written and what's articulated (phonological awareness) is the way to gain access to the lexicon that we use to communicate. If we indeed pay attention to the basic elements that compose the written sentence, we find letters, syllables and words. However, the smallest significant element of the sentence is probably the grapheme, since the whole understanding process derives from it. The grapheme is the written equivalent of the oral phoneme. It is comprised of the smallest group of letters making a phoneme. For example, in French, the phoneme [o] has several graphemes : o, au, and eau. Unlike a letter, a grapheme represents better the phonology of a language, or what a language sounds like. The French language counts 130 graphemes.

Does this same concept apply to a painting or an image ? Just like in the reading process, the image undergoes several mutations between the retina and the sensory areas of the cerebral cortex, whereby the basic components of the image (forms, colors, orientation of the lines) are dissected first and then transmitted to the visual areas. It is only then that the image is reconstructed, and that it will be confronted against other known representations that are stored in our memory for an identification of the present image. Dismantling, reassembly and identification are the three steps in the process of the visual representation, whether artistic or natural.

The time spent in front of a work of art is known to be very short (10-45 sec) ; in this time lapse, the spectator leaving the art piece stores in his neurons a permanent image made of sharp zones and less sharp ones. Using Matisse's *Odalisque a la culotte grise* as an example, figure 1a points to the areas of interest of the painting, and figure 1b represents the painting as seen by the fovea with a few sharp areas standing out from a fuzzy background (5). It is based on these foveal and peri-foveal elements solely that the spectator will understand the meaning of the message that the artist wants to convey, not only at a purely semantic level, but also at an esthetic and emotional level. The painter Avigdor Arikha defines this process : « Similarly to the function of grammar in a string of words, the pictorial constituents operate the picture – dot, line, form and colour in a state of tension – that underlie depiction. It is analogous to a succession of segmental phonemes that constitute a sentence» (6). Thus the reading of a sentence and the « reading » of an art piece seem to be similar processes.

We would thus like to equate visual units and graphemes. Like in reading, the basic visual element in the work of art carries an information that once integrated within the rest of the visual « sentence » will make sense. This basic element can be explicit, but still has a polysemantic potential at this stage. It must be linked to other basic elements or visual units in order for the image or the art to be understood as a whole and make « one » sense only. Can one infer that the understanding of the image is dependent upon the number of fixations? Does the number of fixations correspond to the number of fixations necessary to transition from a polysemantic vision to a homonymous vision ?

Fixation can be equated with the time necessary to identify the smallest significant visual unit in an image. Just as a phoneme is the smallest articulated unit, and a grapheme is the smallest written unit, we suggest opsieme as a designation for the smallest significant visual unit : « opsie » – from the Greek ops, opsis, which means eye, vision and « eme », suffix which signifies basic unit.

Figure 1 : *Odalisque a la culotte grise* (Matisse)

a b

c

a - the original

b - areas of interest

c - foveal and perifoveal visions

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Karina Moraes Zarzar

Paper: Regionalism versus Universalism, Jan Jans's OLTHA Farmhouse

Topic: Architecture

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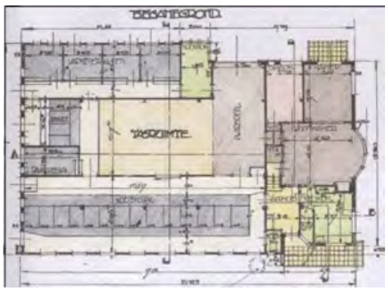
Abstract:
This article is the third presented in the GA conferences whose aim is, first, to uncover signs of regionalism in The Netherlands in general, and second, to reflect on the term "identity" in GA architecture. By analysing the numerous approaches towards identity – as embodied in architectural regionalism – one might get insights into how to reinforce the identity and uniqueness of cities in GA programs. These articles provide some reflection on the term "identity" by illustrating it with cases in architecture in the hope that generative codes can be developed loaded with the numerous faces of regionalism.
This article discusses the seminal 1927 project of Jan Jans (1883–1963) called the *OLTHA boerderij* (OLTHA farmhouse).
Jan Jans was born in Almelo, in the region of Twente, Overijssel Province, in the east of The Netherlands. He was a writer, an excellent draftsman and an architect. As a draftsman he drew hundreds of farmhouses, mills and churches from his region and these drawings are now archived in the Jan Jans Institute. In the process of drawing he undoubtedly got the essence and attractiveness of this architecture, which was often in very decadent state, within the Twentse landscape.
The OLTHA farmhouse was one of the first designs built by him and his associate H. Henneke with their firm "Bouwbureau der OLM" on the occasion of an exhibition opened on 27 August 1927. This building is loaded with his original ideas, and hence has been selected for further analysis.
This article shows a third approach to regionalism, to show the essence of an architecture which did not want to be absorbed by a nationalist architecture. It also reflects on whether this iconographic architecture, which accommodates modern farmhouses, could bring solace against the power of globalism.
Our main questions refer to identity, innovation and sustainability, in particular examining how the OLTHA farmhouse relates to these issues.

Sketch of the Oltha farmhouse



Plan of the Oltha farmhouse

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Keywords:
Dutch Regionalism, Globalism, Jan Jans, OLTHA farm-house

Regionalism versus Universalism
Jan Jans's OLTHA FARMHOUSE

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Jan Jans, Almelo

Premise

This article is the third presented in the GA conferences whose aim is, first, to uncover signs of regionalism in The Netherlands in general, and second, to reflect on the term "identity" in GA architecture. By analysing the numerous approaches towards identity – as embodied in architectural regionalism – one might get insights into how to reinforce the identity and uniqueness of cities in GA programs. These articles provide some reflection on the term "identity" by illustrating it with cases in architecture in the hope that generative codes can be developed loaded with the numerous faces of regionalism.

The research is part of a project to study how Dutch architects in the 20th century faced questions of regionalism and universalism. In this project a representative case study is carried out per selected architect. This particular article presents the study of Jan Jans' (1893–1963) OLTHA *boerderij* (farmhouse), built in Twente in 1927. Jans was very active in the regionalist movement of Twente, which spanned several fields such as literature, economy and politics.

In the first article on Berlage's Stock Exchange (1898–1903) in Amsterdam, we have seen that regionalism was equated with tradition mainly coming from Europe. So elements of the Stock Exchange were taken from places such as Siena and Florence, recombined and adapted to form an innovative design, which inspired both expressionists (the Amsterdam School) and modernists (De Stijl). It goes without saying that these references were not recollected as quotations. Their functions were well understood by Berlage, recombined with other elements and applied. In the second article, two projects were analysed: Van Winden's Inntel Hotel (2006–2010) in Zaandam and Geurst's Le Medi (1999–2008) in Rotterdam. Both projects used references in a Disneyism fashion, with the first using references which represent the "original" inhabitants of the area of about two hundred years ago, and the second using references which represent the culture of the first and second generations of Turkish and Moroccan immigrants in a setting which turned public areas into semi-public ground. After analysis, the projects' advantages and disadvantages were presented at the end of the articles.

Also in this article, our main questions refer to identity, innovation and sustainability, in particular examining how the OLTHA *boerderij* relates to these issues.

1. Regionalism

Eleftherios Pavlides in his article "Four Approaches to Regionalism" (1991)[i] examines "how local influences have been used to generate local character in architecture, which has been called 'regionalism' in architecture". Regionalism, Pavlides says, is the architect's response to vernacular regional architectures.

He examined four distinct academic traditions which have been applied to the study and teaching of regional vernacular architectures. According to Pavlides, these four kinds of regional vernacular responses – folkloric, ideological, experiential and anthropological regionalisms – need not be mutually exclusive of one another. As an example, he says that a designer can simultaneously evoke an original archetype employing elements for their symbolism (folkloric regionalism), utilize principles of modern architecture that have been justified through reference to the vernacular (ideological regionalism), echo the material qualities and the spatial character of the vernacular as analysed by the architect (experiential regionalism), and respond to the user's perception (anthropological regionalism).

One might have doubts about the ideological regionalism. The use of vernacular elements reinforces an approach toward regionalism only if the vernacular reference belongs to the specific region where one will build. So Le Corbusier's piloti of the savage hut in its original environment was a regional characteristic, but when it is transferred to other countries it cannot be consider a regionalism. It might be considered a good solution to free houses from humidity or to free the view to the horizon but it is still not regionalism. There are modern architects concerned with region such as Alvar Aalto, but his practice is different from the syncretism that Le Corbusier used in his Citrohan villas and Unité d'Habitation. One could perhaps speak about the creation of a new tradition as Sigfried Giedion would call the modernism of the 1920s.

Pavlides' taxonomy shows the complexity of the concept of regionalism, and when he argues that these categories do not need to be mutually exclusive, he partially destroys his classification.

Another problem with Pavlides' four approaches is the fact that they refer to an instant in history. Tzonis and Lefaivre in their "Architecture of Regionalism in the age of globalization, Peaks and Valleys in the Flat World"[ii] discuss the dynamics of regionalism and universalism. They show how a product of globalization can become part of a regionalism. An example is given with Ancient Greek architecture, which was made through a recombination of its own inventions and products imported from numerous civilizations. Later it transformed itself into a legitimized identity, a tool to rationalize the Greeks' domination[iii] of the world. This view of regionalism as a process can shine some light on the way one can be critical in the use of regionalism as a pure expression of regional architecture elements.

2. Introduction: Jan Jans, 1893–1963

Who was Jan Jans? Social, political and cultural context

Jan Jans was born in Almelo, The Netherlands, in 1893. He started his career as a carpenter, and afterwards went to study at the Technical School in Zwolle. After Technical School he moved to Amsterdam where he would stay for 14 years before returning to Almelo. Besides being an architect, Jans was also known as a remarkable draftsman, researcher, writer and lecturer.[iv]

In contrast to the other architects previously studied in this research project, Jan Jans considered himself a regionalist. From his early youth he sketched and painted farmhouses, windmills, traditional buildings and streets of old villages and towns. This activity would make him observe the materials, proportions and signs of the regional culture. Significantly, this interest also led him to focus on the landscape and its relation to farmhouses.

Jan Jans moved to Amsterdam in 1914 to work for the architectural firm Gulden & Geldmaker. At that office he met Hein Henneke, who would become his partner at the OLM office and later. During these years in Amsterdam, he read Dr. Werner Lindner's work "*Das niedersächsische Bauernhaus in Deutschland und Holland*" (The Lower-Saxon Farmhouse in Germany and Holland), which included some farmhouses in Twente. He also read Van der Kloot Meyburgh's book on village churches and farmhouses illustrated with line drawings. Both publications influenced Jans and helped him to understand the architecture of the countryside, especially that of his region[v]. Another major influence was the magazine "*Wendingen*", in which Berlage, De Bazel, Granpré Molière and De Klerk contributed numerous articles[vi].

In 1926 Jans went travelling with his colleague Hein Henneke. They travelled by train as far as Neu-Müster and then continued by bicycle to Denmark[vii]. It was at this time that Jans realized that the idea of region is not so much determined by political power as by language and culture.

Jan's position on his contemporaries:

Berlage and Laotse: according to Löwik, many ideas found in Berlage's articles are echoed in the articles of Jan Jans, such as the concept of simplicity and architecture as the art of space creation[viii]. In his "*Bouwkunst en Cultuur*" (Architecture and Culture) Jans refers to Berlage's Stock Exchange (1903) as a kind of brick-and-mortar textbook on architecture [ix]. However, the definition of architecture as the creation of space could have derived from Jans' reading of Laotse, as he describes in "*Bouwkunst en Cultuur*". According to Jans, Laotse found the space created by a building more relevant than the actual building itself. Convergence of thoughts or not, for Laotse as well as Berlage, buildings should be designed from inside to outside, the walls being the elements used to determine the space created.

Amsterdam School: though not against decorative elements, Jans disliked the Amsterdam School's "obsession" in producing decorative façades which often dictated the interior of the building, creating spaces that were not well lit or divided.[x]

Delft School: Jans was aware of the ideas and concepts of Granpré Molière and his Delft School through his reading of the "*R.K. Bouwblad*" (Catholic Building Magazine), a periodical which covered the ideas of those who refused to abolish Dutch tradition[xi]. Once again, the similarities could be a kind of convergent evolution. Granpré Molière was a Catholic and from this perspective he developed what came to be known as the Delft School. Jan Jans was a socialist, and although not an atheist, he had a very personal opinion about God[xii]. His drawings were guided more by his political position.

Jans' OLM Architecture Office: The general principles that Jan Jans and Hein Henneke followed with their OLM architectural office at the time of the OLTHA farmhouse were:

1. Renovate old farms and, while minimizing drastic changes, make them suitable for modern business needs;
2. Build new buildings as modern, inexpensive and typical as possible;
3. Organize courses where architects from the countryside can learn to renovate farmhouses without disfiguring them;
4. Disseminate propaganda among all parties involved in building to adhere to good architecture, in particular good countryside architecture[xiii].

Jans' multifaceted concept of regionalism at the time of the OLTHA farmhouse can be partially discussed using Plavides' four approaches to regionalism. It does not fit into one category; in fact it can be clearer using the four approaches.

From the folkloric regionalism it coincides in his use of typologies. However, contrary to Pavlides' folklorism, Jans finds essential the relation of the house to its topography and landscape.

From the modern approach, he has the functional plan layout, by trying to modify the farmhouse to satisfy the need of production modernization. However, he opposed functionalism as an end in itself. Contrary to the modernists and their *Neue Sachlichkeit* (New Objectivity) (1918–1933), Jans developed the concept of *Nieuwe Hartelijkheid* (New Cordiality), leaning substantially on his socialist consciousness, cultural awareness and the region's characteristics.

Experiential regionalism is the approach, says Pavlides, directly connected to Rudofsky's book "Architecture without Architects". According to Pavlides, Rudofsky goes beyond picturesqueness and formal aesthetic qualities evident in the material. Like Rudofsky, Jans sought to identify and present the experiential qualities of regional vernacular architectures. The experiential regionalism of Jans refers to the "*sfeer*" (ambience/atmosphere) that makes architecture more than just a worthy technical performance. He defines the ambience as the expression of a spiritual content. A building without ambience (atmosphere) is just a technical performance. If the building has something which warms us, then it has the atmosphere of an artwork. A building should tell us something of the emotion expressed in the enclosed spaces. Ideally, the enclosed space must also be outwardly expressed. In other words, a building should express the properties of the enclosed space.[xiv]

Jans' books "*Bouwkunst en Cultuur*" (Architecture and Culture) (1934) as well as "*Volkscultuur en Bouwkunst*" (Popular Culture and Architecture) (1938) point to the fourth approach, anthropological regionalism. Jans was a very talented draftsman who, in long biking tours through the meadows, ceaselessly drew farmhouses and barns in their context as well as symbols used on the main doors and roofs of the farmhouses. The lifestyle of the farmer, he said, was well known, and he visited hundreds of farmhouses and would sit chatting with the families in their living rooms. However, he acknowledged that no one could ever know precisely how they actually lived within the secluded spaces of their homes.

It is also important to note that Jans did not limit himself to the Twente region, but to the so-called Lower-Saxon region which includes the eastern part of The Netherlands and part of Germany.

3. Precedents of the OLTHA farmhouse

This section shows some of Jans' drawings picturing farms of the *hallehuis* ("hall house") archetype. It shows some characteristics of the *halle* houses that caught the attention of Jans during his biking tours through the east of Holland and Germany. The elements shown here were recollected and reassembled in his OLTHA *boerderij* in what one could call a regional syncretism.

3.1 Halletype

The typical *hallehuis* has the home and work areas of the farmer under one roof. It is a Lower-Saxon type, from the region which comprises part of Germany and The Netherlands.

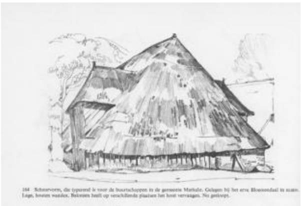
Figure 1 and 2 show a very old *hallehuis* sub-type which has now almost completely disappeared from the Twente region. It is a sub-type called *los hoes* or "open house". The *los hoes* has no separation of living and work areas, few partition walls or fences separating the stables from a bedroom or living room. The cattle, pigs and sheep are taken through the large door at the front of the house to go to the fields and return to their stables, and grain is brought in through the same large door which is positioned toward the road to facilitate the movement of these goods.

1.Farmhouse Nysink in Beerze: Lös Hoes type (Ommen municipality, Salland, Overijssel province)

2. Interior of a Lower-Saxon farmhouse, painted by Hermann Daur (1902)

Initially, wealthy farmers constructed their houses at the back of the farm building but mostly under the same roof, keeping the large door facing the road. But farmers from the South-West Drenthe province in particular, noticing that they were losing a lot of storing space due to the entrance needed for vehicles bringing grain to the storage area and the movement of cattle in and outside their stables, repositioned the main entrance to the working areas on the longitudinal side of the farmhouse.[xv]

Crossing the fields of Drenthe nowadays, one can hardly find a house which does not face the road. Probably the rotating of the house was made possible due to the positioning of the *nienduurn* (large door to enter the work area) on the longitudinal side of the building (Figures 3-5).



3. Barns in hamlets of Markelo municipality

4. Hoeve in Staphorst. Latter half of the 19th century.

5. Nienduurn

This innovation made a complete reorganization of the building possible. It is called the "*dwarsdeel*" type, a name which refers to the transversal entrance into the working area.

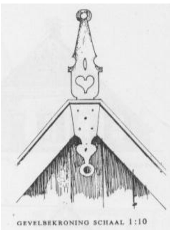
Other elements that one may see in Jans' drawings are the *wolfsdak*, the *oelebord* and the *gevelteken* (gable signs).

The *wolfsdak* (Figure 6) is a gable roof with two sloping surfaces on the short sides. These sloping surfaces are called *wolfseind*. The slope of these ends is often steeper than that of the adjacent large roof surfaces. It is found in abundance in Drenthe and Overijssel[xvi].

6. Wolfsdak

The *oelebord* (“owl board”) is a small triangular plate at the confluence of three roofs (Figures 7-9). It is used to protect against the ingress of rain[xvii].
The *oelebord* has one or more holes on its surface to allow owls to find a good place to make their nests. The owls were welcome for their hunting which reduced the mouse population and potential pest problems.
Almost all elements of the farmhouse came into being for their functionality. One of the few exceptions are the *gevelteken* which are found on the *oelebord*. They symbolize the identity of the farmers. According to Jans, “These gable signs show a practically unlimited number of varieties. Traditional forms are motifs of horse heads, tree-like symbols, heart-shaped signs and the Christian cross.”[xviii]

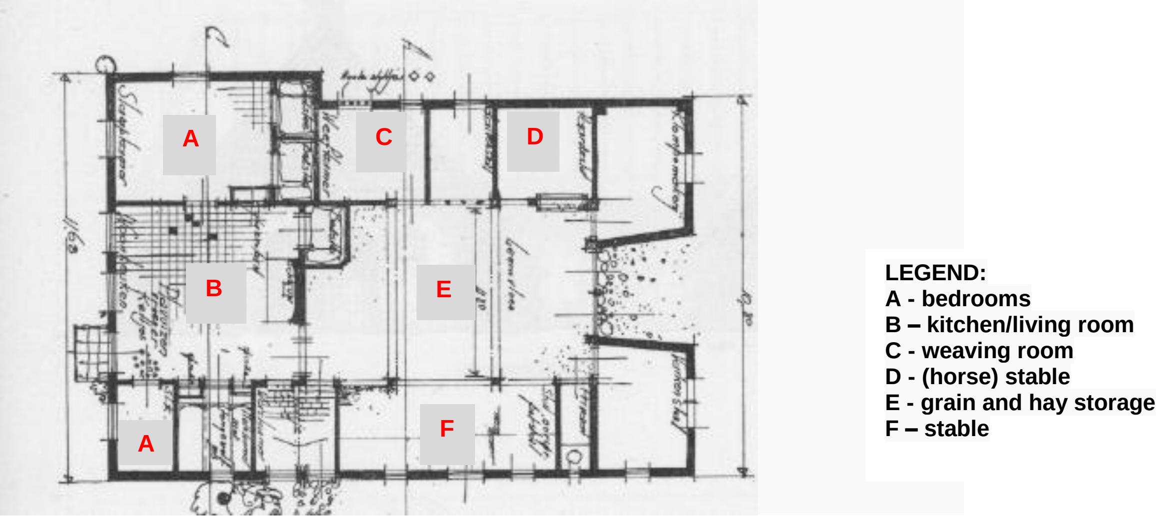
7. Oelebord with a gevelteken



8. Gevelteken of the Erve De Borg, 1840, Rekken, Eibergen

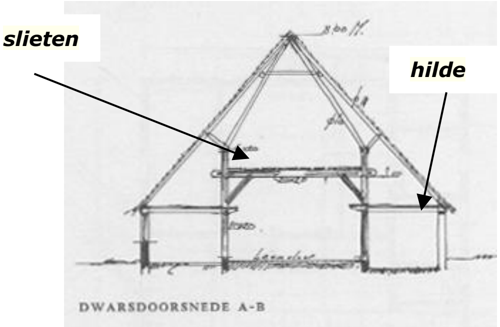
9. Oelebord with gevelteken, Orvelte, Drenthe

Structure: The *halletype* generally has a three-aisle structure, with the lateral aisles mostly used as stables but also as bedrooms and weaving room (Figure 10).



10. Plan layout of the Erve De Borg, 1840, Rekken, Eibergen

The central nave was used for storing grain and hay. Grain and hay were also stacked on the *slieten* (attic on the central aisles – Figure 11) and on the *hilde* (area on top of the stables – Figure 11).



11. Transversal section of the Erve De Borg, 1840, Rekken, Eibergen

It is interesting to note that some decorative motifs are based on function, such as the façades of the farmhouses in Orvelte, Drenthe (Figure 12). The thatched reed is more than just an ornament, it is used to ventilate the spaces inside.

12. Thatched reed on the façades of a farmhouse in Orvelte, Drenthe

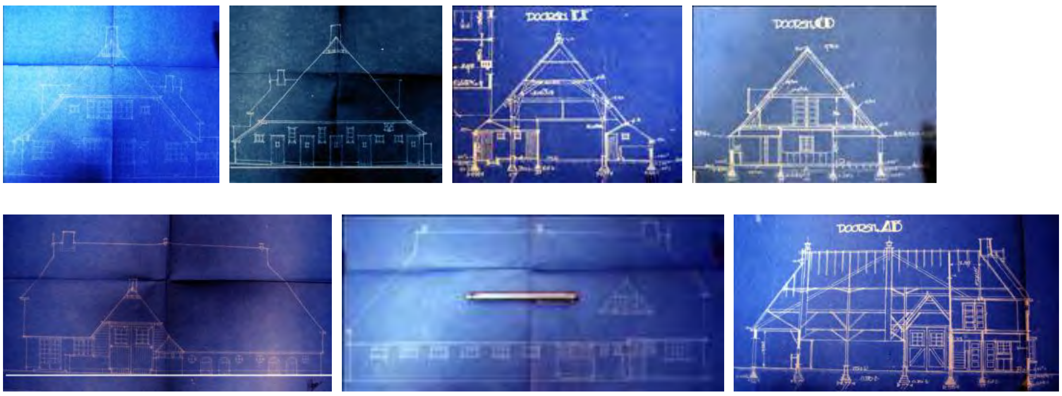
4. Improving the halletype: OLTHA farmhouse, Twente, 1927

The problem of the traditional *halletype* for the modern farm:

According to W.C. van der Meer and H.T. Tjallema, the Twente *halletype* presented many obstacles, especially for mixed farms. The main problems were: too little storage space through the wide part in the middle of the farm; storing the harvest takes too much time and labor; storing the hay in the *slietenzolder* (loft) and *hilde bar* (aisle truss bar) produces too much dust in the working area; and finally, the cattle stand in an area that is too cold, making them restless[xix].

The OLTHA farmhouse:

13. The OLTHA farmhouse

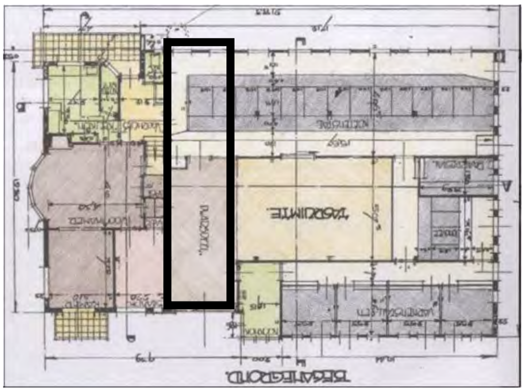


14. Drawings of the OLTHA farmhouse

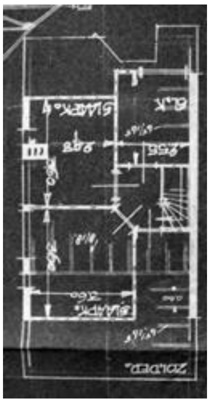
The OLTHA farmhouse (Figure 13 and 14) aimed to improve the *halletype*, making it as modern, inexpensive and typical as possible of the West Twente type. The principles for improving the traditional *halletype* were: storage of hay and grains from the ground up in the so called *tasruimte* in the middle of the farm where it is highest (central nave); making stables along all exterior walls where possible; and creating enclosed stables as much as possible.[xx]

The characteristic elements required to make the farmhouse as typical of West Twente as possible were: a *nienduur* (large barn door at the entrance of the work section); a *wolfsdak*; an *oelebord*; and a robust building with monumental roof. The OLTHA farmhouse did not have a thatched roof or timber façades or timber partition walls; however, its tiled roof and the masonry were already a tradition in the east of The Netherlands.

The plan layout is modern (Figure 15 and 16), aiming to produce a building that is as economic as possible and an efficient modern farmhouse. The living area is located in front of the building separated from the work area, but under the same roof. There is access from the home to the work area, but if necessary the circulation can be disconnected since both parts have their own access from the outside world. The farmhouse, given the lateral entrance, is more close to the "*dwarsdeel"* type due to the use of the *nienduur* at the longitudinal façade and the *wolfsdak*. It is interesting to note that the plan layout below is the most well-known, however, this plan does not completely match the one found in the archives at the Enschede town hall. In the archive version, the *dwarsdeel* goes from the *nienduur* – the transversal entrance for vehicles bringing the harvest to a secondary door on the opposite side (Figure 15), which is what was indeed built. This could be used by the cattle, but also for small cars, enabling them to avoid reversing out. In other words, it makes the plan more efficient.



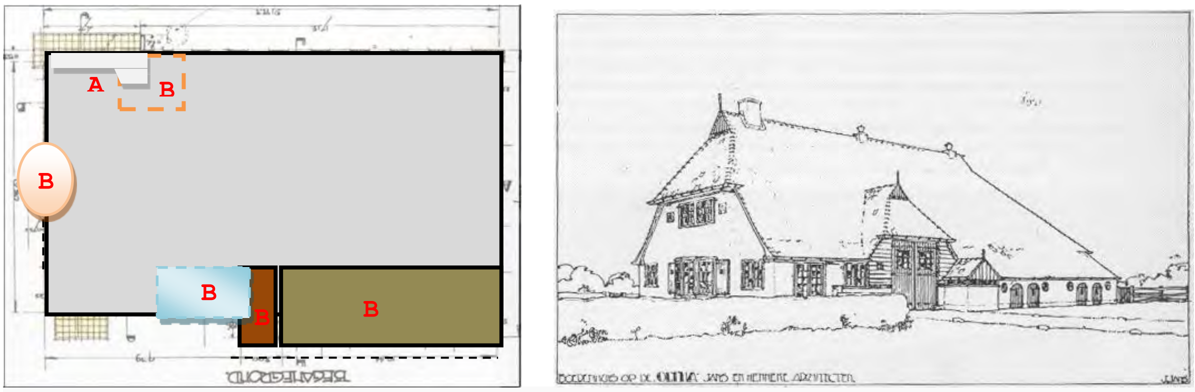
15. Ground floor



16. 1st floor

17. OLTHA farmhouse

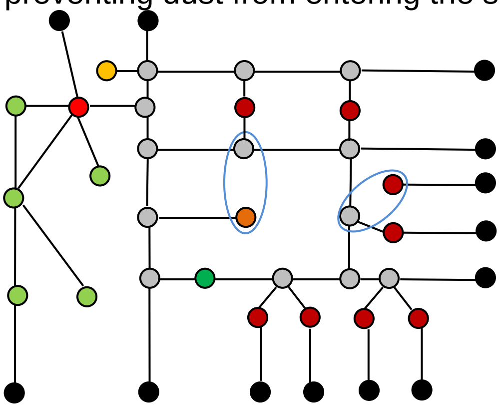
Spatial relationship: monumental roof
On the kitchen side there is a small subtraction of the main body of the farmhouse. Small elements such as the *nienduur*, swinery, oriel and a secondary kitchen interlock with the main body reinforcing its dominant presence (Figure 18). The *wolfsdak* in red tiles reinforces the monumental character of the building.



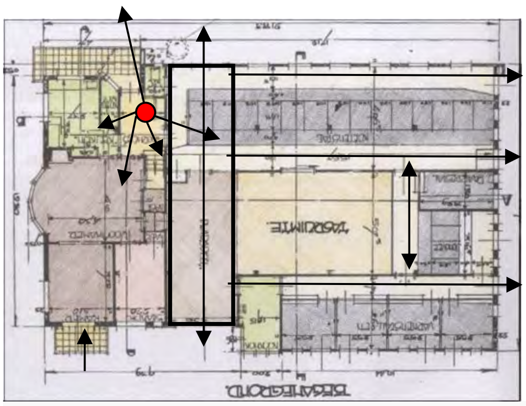
18. Spatial Relationship: A – Subtraction B - Interlocking elements: nienduur, window of the bedroom on the second floor, secondary kitchen (for preparation of animal feed) and swinery

Topology: accessibility

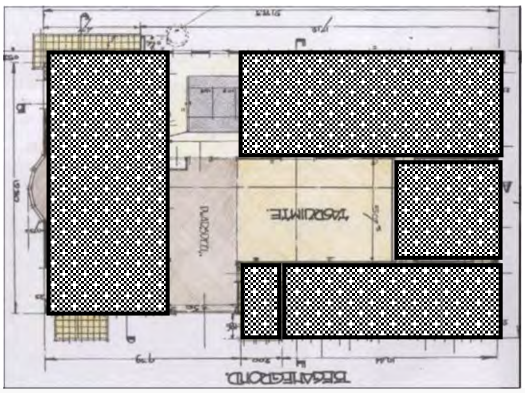
Living areas, stables and storage areas are separated in the OLTHA farmhouse (see illustrations below). However, all the spaces are accessible in a linear path passing sometimes through spaces, other times by spaces (Figure 19). The hall of the home (red dot – Figure 20) has a network function, connecting the outside world with the kitchen, stairs, living room and the working area (*dwarsdeel*). In the working area, each stable has access to the outside, which facilitates the cleaning of the stables but is probably also used for bringing the animals in and out. The storage room (*tasruimte*) is easily accessible via the *nienduur* and it is an enclosed space, preventing dust from entering the stables or the living area !Figure 21).



19. Access: path configuration: (mostly) path through space – black dot = outside



20.Circulation to use



21. Enclosed stables and living quarters

6. Reflections

According to Jan Jans, “what’s more important than preservation or restoration is when, inspired by the old, one knows how to give shape to the new. The regionalists, who strive for this ideal, don’t preach scary regional chauvinism, but rather a spiritual growth. Healthy regionalism rejects provincialism as much as unrestrained cosmopolitanism.”[xxi]

This is also the position of the Critical Regionalists[xxii], being critical of regionalism as much as of the products of globalization. However, the Critical Regionalists, by using defamiliarization as a design tool, attempt to come to more innovative projects. By making the familiar unfamiliar (defamiliarization) but coping with the ever-changing life condition, they prick the mind of the people and give them an awareness of the present.

The OLTHA farmhouse satisfies all the functional aspects proposed at the beginning of the design process. Despite its changes one could consider some further changes to the style of living it offers.

The OLTHA farmhouse was built in 1927, when the modernists were designing in the zeitgeist with an eye to the future and linking mechanization with free time for all people. Analogous to life in the city, with the mechanization of agriculture, some free time might have been gained for the farmer and his family. Though compromising with the present, this project is too bound to the past due to its composition.

According to Jans, tradition is precious as long as it provides the means with which architectural issues can be resolved in the spirit of the time, to the perfect satisfaction of the client. If this is not the case, then even the most attractive tradition becomes reactionary (counteractive) and all our efforts should be focused on developing the foundations for a new tradition.[xxiii] It was perhaps the time to develop this new tradition.

Jans, as a gifted and prolific draftsman, built an immense archive of innumerous aspects of the farmhouses of the east of The Netherlands. As an architect, he used numerous subtypes of the *halletype* as precedents in a regional syncretism. Perhaps his talent as a draftsman worked against an abstraction of the design elements, resulting in an over-familiarized use of precedents. It might have been that for Jans, the time was right for a new use of the farmhouse, but the aesthetics did not follow the same path. The aesthetics might have been entangled in its deep cultural roots.

The plan layout, though, might have provoked an element of surprise and estrangement for the inhabitants who were used to living with a more traditional and simple plan. Nowadays, many of the old farmhouses are being transformed into homes. The OLTHA farmhouse, after the exhibition it was part of, was transported to Witbreuksweg no. 204 in Enschede. It would be interesting to see how sustainable and adaptable it proved over the years.

For GA programmers, the question remains how to produce a tool for generating a critical architecture, to reinforce the identity of the place and create unique cities away from the flat world. In other words, to create a tool that generates buildings far from a soulless architecture but also far from the picturesque. How can we encode this regionalism with all its facets? This is a question for the programmers, but molded by the regionalist architect.

Postscript: It goes without saying that these reflections refer only to the OLTHA farmhouse and do not extend more broadly to Jans' oeuvre. To get a better understanding of the architect Jan Jans, one should analyse several projects to examine whether there were some shifts or transformations of his initial principles.

References and endnotes

Documentation of the OLTHA *BOERDERIJ*: courtesy of the Enschede town hall archives

Graphic material: Jan Jans. 1967. Landelijke Bouwkunst in Oost-Nederland.N.V v/h Firma M.J. van der Loeff; with the exception of OLTHA perspective on page 10 which comes from F.G.H. Löwik, 2003, Jan Jans: Leven en Werk (1893–1963,Almelo: Van Deinse Instituut

Photographs: all by Karina Moraes Zarzar, with the exception of the black and white photo of the OLTHA farmhouse on page 10

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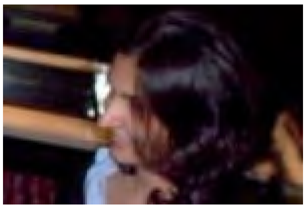
Dr Mahnaz Shah

Paper: **Generative City Code: The Case of Le Corbusier's Potato Building Typology 1962-65**



Topic: ***Architecture***

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Abstract:
What is the form and meaning of the contemporary city? Does the designation of the city still apply to modern day urban zones with sprawling edges? Is it possible to talk about countryside if one encounters similar densities there as in the city? Does the dispersal of the city also mean its dissolution? The above are some of the questions that were raised by Greyter Architects (2002) in their quest to determine the essence of contemporary city. Their study entitled '*After-sprawl'* demonstrates that today urbanity is not based on the classic dichotomy of 'city-countryside', but defined by the state of 'sprawl' – the filling up of the landscape has now become the pattern of the settlement of ever greater expanses of western Europe. Similarly Rem Koolhas in his book entitled, '*The great leap forward'* refers to 'an urban free of urbanity'.

This paper aims to review the above questions and concerns by presenting a possible case study; the proposed typology that Le Corbusier and his associates were developing at the atelier between during the early to mid 1960s. According to Le Corbusier the key solution was a generative design that evolved as a dynamic organism but sans form – and hence the term 'potato building typology' was coined at the atelier Le Corbusier. It is proposed that this study can lead to formulating a number of well-established horizontal city exchange systems along with their strengths and weaknesses. These systems once determined and categorized can be an excellent starting point in the study of the future growth of the city.

The typology as structured and discussed below can become a starting point in generating an urban code that identify a sense of sequence or pattern through the formation of positive public spaces, such as squares. These spaces define focal points and determine a dynamic pattern that can be replicated in the rest of the urban fabric.

This investigation at one level is important as it provides an overview of a body of research that directly addresses the horizontal urban fabric as an independent entity and at another level it hopes to give the dweller/ consumer a diagram that can assist to further develop the fabric according to personal needs and aesthetics. This research is envisioned to initiate an understanding of generate urban codes that approach horizontal urban growth as an important step in future community building.

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Keywords: *typology,* horizontal circulation, urban planning

Le Corbusier's Potato Building Typology 1962–1965: An Analysis

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Abstract

What is the form and meaning of the contemporary city? Does the designation of the city still apply to modern day urban zones with sprawling edges? Is it possible to talk about countryside if one encounters similar densities there as in the city? Does the dispersal of the city also mean its dissolution? The above are some of the questions that were raised by Greyter Architects (2002) in their quest to determine the essence of contemporary city. Their study entitled '*After-sprawl'* demonstrates that today urbanity is not based on the classic dichotomy of 'city-countryside', but defined by the state of 'sprawl' – the filling up of the landscape has now become the pattern of the settlement of ever greater expanses of western Europe. Similarly Rem Koolhas in his book entitled, '*The great leap forward'* refers to 'an urban free of urbanity'.

This paper aims to review the above questions and concerns by by presenting a possible case study; the proposed typology that Le Corbusier and his associates were developing at the atelier between during the early to mid 1960s. According to Le Corbusier the key solution was a generative design that evolved as a dynamic organism but sans form – and hence the term 'potato building typology' was coined at the atelier Le Corbusier. It is proposed that this study can lead to formulating a number of well-established horizontal city exchange systems along with their strengths and weaknesses. These systems once determined and categorized can be an excellent starting point in the study of the future growth of the city.

The typology as structured and discussed below can become a starting point in generating an urban code that identify a sense of sequence or pattern through the formation of positive public spaces, such as squares. These spaces define focal points and determine a dynamic pattern that can be replicated in the rest of the urban fabric.

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Introduction

Late 20th century and early 21st century architectural and urban discourses are replete with the catch-phrases 'horizontal urban sprawls' and 'after-sprawls' respectively, as urban and architectural theorist and historians try to grapple with the increasing complexity of the contemporary city's expanding perimeters and infrastructural design and logic.

It is important to review the above questions and concerns by a detailed study of past and present horizontal city systems, in particular a number of select medieval water cities. It is proposed that the study will determine a number of well-established horizontal city exchange systems along with their strengths and weaknesses. These systems once determined and categorized can be an excellent starting point in the study of the future growth of the city.

The resultant project is envisioned as generating an urban code that identify a sense of sequence or pattern through the formation of positive public spaces, such as squares. These spaces will define focal points and determine a dynamic pattern that can be replicated in the rest of the urban fabric. Initially this exercise maybe of a purely aesthetic nature, however after a number of patterns are determined, then geometries can be identified and applied to the rest of a proposed urban fabric – from positive public spaces to private dwellings.

As a case study I will present the lesser known research of the Swiss/French Architect Le Corbusier's oeuvre particularly in the final years of his life; the parameters of Potato Building typology – with its direct affinity to the medieval urban configuration of the city of Venice, will be introduced along with the possible future direction in devising it as a generative urban code.

Research Direction

The research aims to analytically deconstruct the modern day city's horizontal expansions, to locate its essentially weak design elements and then reconstruct a computational alternative horizontal expansion, by a series of generative codes derived from the detailed analysis of select medieval cities, in particular the medieval water cities, for their distinct essence and characteristics.

This decision has been taken by keeping in account the importance and dynamism of water in most European cities. In the '*Water Cities'* exhibition held at the *2nd International Architectural Biennale Rotterdam* (2005), it was argued that a great many European towns and urban expansions have usually been shaped by the infrastructure and rail connections when – considering the water tradition in most western European cities, one would expect the planners to take advantage of the rivers, the coast, the tidal basins and the lakes. According to Adriaan Geuze, the curator of the Biennale: these (water areas) are the very places where you can develop attractive towns and cities, but this turns out to be exceptional.

It is hoped that the study will contribute in the research to revive the essence of the ever-expanding contemporary city along with providing a series of generative codes to determine proposed future urban models to determine city's horizontal expansions.

Research Method

The method used will be based on the Generative Design approach as introduced by Prof. Celestino Soddu at the Generative Design Lab, Department of Architecture and Planning, Politecnico di Milano University, Milan.

Generative Design is a logical synthesis of a creative process using transformation rules (algorithms). It can be realized to design a program that is able to simulate this process and to generate outputs as 3D models of architecture, cities and objects. The ability to design accurate 3D models based on the diagrammatic representations of the spatial configurations as determined by the above detailed onsite studies would be extremely beneficial in a number of ways:

1. Generative Design could be represented like a morphogenetic meta-project, an organized idea of "how to run" a design process.
2. It involves subjectivities going more in depth into complexity of (architectural, town environment, industrial objects…) designed artificial systems.
3. It has the ability to move from axonometric to perspective view. Adding subjectivity one can move from the axonometric representation, "objective" because free from subjective views but limited by the dimension of the sheet, to the perspective view that, using subjective points of view, can represent the infinite in one sheet and, following that, the increasing complexity of represented systems.

Design strategy

The proposed research outlined above will be an initial attempt in determining the horizontal exchange system of the contemporary city along with its future expansions, through the lens of past planning solutions and their reinterpretations in the current urban scenario.

Le Corbusier in his final Venice Hospital Project 1964-65, did try to attempt a similar planning solution (by trying to replicate the program of the city of Venice in his hospital project – this was studies in depth in the author's PhD research study). However his untimely death in 1965 – a year after his acceptance to design the hospital project, halted the project, along with further research along the lines of developing a unique typology that he termed as the potato building typology.

Given an opportunity this research hopes to continue in the tradition of looking in the past for the solutions of the future. Along with deriving 'state of the art' city sequences and patterns as generative codes, determined by the generative design method. It is hoped that these will be further explored and modified by the designers of the future.

The uniqueness of the Generative Design method lies in the fact that it is a subjective operative meta-project, that can be used to design a kind of artificial objects, an artificial DNA of a species of objects because is oriented to set up a process and not only to reach one result. More, it defines and renders explicit all the steps of a "normal" design process, from the first sketch to the final executive project.

The generative design approach is not a technology but a philosophy. It identifies a particular approach to understand, design and manage the incoming complexity of artificial systems, cities, architectures, environment, objects. It can be easily transformed in technological tools because it uses transforming rules that can be easily written in algorithms.

The proposed research can be succinctly outlined into three main phases:

Initial phase includes an in-depth investigation of the urban configuration of medieval horizontal city planning. The case study presented is an initial step in this direction.

Second phase requires the consolidation of the above research to identify coherent and efficient horizontal city systems that can be translated and applied in the future horizontal growth of the city.

And the third phase is to create Generative codes, based on the above system analysis and formally apply these by using the Generative Design Method in the virtual context – so as to critically evaluate its viability and application in proposed actual case studies.

Case Study: Le Corbusier's Potato Building Typology 1962–65

Une telle disposition des bâtiments est une *conception paysagiste*. nous connaissions le site a merveille; nous sommes loin de la ville, le lac, les arbres, les prairies, les montagnes, des horizons immenses. On ne pouvait songer a une conception urbaine, forum, piazza de Venise, place de l'opéra, etc., ou des successions de rues, de places, des masses de bâtisses diverses peuvent épauler les coupoles ou les dômes couronnant une composition pyramidale. Chez nous, la fermeté n'était point dans des soubassements cyclopéens ; elle était en haut, sur le ciel, par la ligne impeccable d'une unique horizontale.

Le Corbusier 1928

As noted above during the later part of his life Le Corbusier moved away from his initial summation of a figure-ground discourse to more of an inside-outside discourse where the distinction between urban/landscape and architecture/built-object becomes secondary and almost irrelevant. In this section I will provide a brief overview of Le Corbusier's extrapolation on the concept of the horizontal within his design vocabulary and hence to further define and therefore understand the significance of the potato building typology.

The key drawings that are now considered as part of Potato building typology studies series are archived under two main projects: the Venice hospital project 1962–1965 included a single yet extremely significant sketch by Le Corbusier and the Musée du XXe siècle, Nanterre, France, 1965, which includes the 16 sketches these are now considered the main point of reference to the typology.

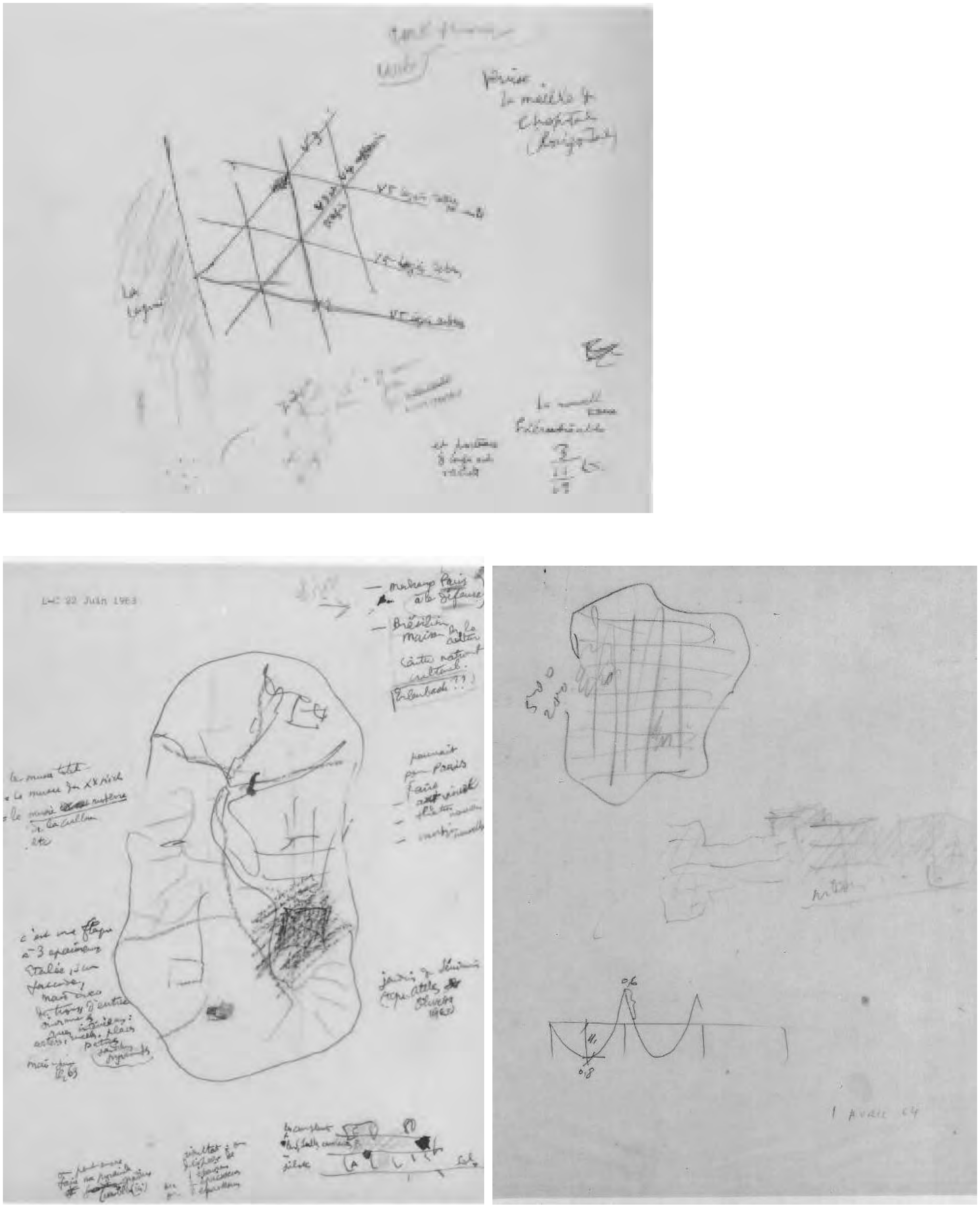

Fig. 1 a,b and c. select drawings from Le Corbusier's Potato building typology series CCA Montreal.

The above drawings distinctly reference the proposed hospital for Venice along with the city itself as important guiding principles in the study of horizontal structures and possible sprawls. Le Corbusier identifies:

1. Venice as a Mesh, outlining the schematic relationship between the lagoon, the *rii* and the *calli*. The proposed hospital project referenced as an important example of this horizontal mesh.
2. Type solution: *sans façade*. Identifying three points of entry, through the interior streets, courts and patios.
3. The logic of the horizontal circulation system is emphasized as well as a restricted building height. The piloti to create a porous geometrical structure.

Based on the above analysis, it can be postulated that in the studies of the 'Potato Building' typology, the medieval urban configuration of the city of Venice was used as a diagram to determine the logic of horizontal circulation in resolving urban planning issues.

It should however be noted here that for Le Corbusier this horizontality of the site, and or the broader sense of horizontal circulation may have acted as a principle of abstraction, in which he continued to disturb and retract the observer at his will. This is further substantiated in Rowe's analysis:

In this idea of disturbing, rather than providing immediate pleasure for the eye, the element of delight in modern architecture appears chiefly to lie. An intense precision or an exaggerated rusticity of detail is presented within the bounds of a strictly conceived complex of planned obscurity; and a labyrinthine scheme is offered which frustrates the eye by intensifying the visual pleasure of individual episodes, in themselves only to become coherent as a result of a mental act of reconstruction.[15]

The idea of a 'mental act of reconstruction' remains an important element in Le Corbusier's later projects and it seems is the key element in understanding the new typology that he was developing at the atelier. In *Une Maison, un palais* (1928) Le Corbusier had identified this mental construct by stating: Jamais l'œuvre architecturale participant du site qui l'entoure n'a dit son dernier mot. [16]

What Le Corbusier initiated in 1928 as an ongoing horizontal discourse between the built object and site, developed in his later years as a substantially dynamic and discursive exercise between a number of horizontally stratified internal and external urban/architectural mechanisms that both connect and refute the viability of the voids and spaces.

Grid-Field-Diagram: Re-contextualizing the typology

Le Corbuiser in a sense introduced a diagram of a typology or rather a dynamic 'urban field'. The essential diagrammatic qualities of this field can be accessed on the basis of an analysis of the city of Venice, with its unique medieval topological growth, its horizontality and irregularity, as the sketches above illustrate.

However, Alan Colquhoun points out that, a diagram can be a number of interpretations based on certain rules. It therefore gives a concept in its simplest form, and in actuality does not correspond to the object of study, but rather is a reduction.[1]

Given the above definition of the diagram by Colquhoun, it can be argued that Quatremere de Quincy's definition of the type, is similar to that of a diagram: the idea of an element which should itself serve as a rule of a model. Here again the rule is presented as the basic possible denominator of a design method, which can be applied and interpreted in a number of ways. Similarly Guilio Carlo Argan's types, approximating archetypes, are regressed or reduced to a common 'root form', type here is more a principle allowing for variation, rather than an a priori set of fixed entities. [2]

The use of typology as a design method acknowledges the presence of precedence, this precedence according to Colquhoun, is an instrument of cultural memory, and operates as a condition of architectural meaning.[3] Memory and meaning are both subjective entities and take occasional recourse to intuition. According to the Italian theorist Tomas Maldonado:

The area of pure intuition must be based on a knowledge of past solutions applied to related problems, and that creation is a process of adapting forms derived either from past needs or from past aesthetic ideologies to the need of the present.[4]

In the potato building typology Le Corbusier uses the city of Venice as the prime precedence. Here the city is analyzed for its past solutions, for its complexity, its history and its ability to integrate past aesthetic ideologies to the need of the contemporary sensibility. Le Corbusier adopts the physiology of the city history – a city built over large wooden stilts inserted in the salt waters – hence identifying the field like grid, rather than the medieval configuration of its urbanity in the form of the pinwheel system.

Le Corbusier was familiar with the city's historical development along with important artists and cartographers such as Cristoforo Sorte (1506 –1594), the use of Euclidian geometry featured prominently in most works of the time along with Palladio's *The Four books of Architecture* (1570) as a key text accentuating the inter-relatedness of the built object within the context of the immediate landscape.

The field like grid introduced by Le Corbusier in the potato building typology may also have been influenced by speculative geometry particularly popular during the high Renaissance. According to Cosgrove (2002) the speculative side of geometry was regarded as far more exalted than the practical, for only a theoretical discourse is certainty possible.[5]

The potato building typology can thus be given two main attributes; one relating to deterministic geometric type solutions and the other alluding to intuitive discourse based on plastic events. According to Le Corbusier, these plastic events; are not regulated by scholastic or academic formulae, they are free and innumerable.[6]

This can be particularly pertinent within the context of the recent shift of emphasis in architectural and urban projects – from the design of enclosed objects to the design and manipulation of larger urban surfaces. The effects of urbanization today are multiple and complex, but two are of particular significance with regard to planning and design.

1. First is the rise of new kinds of urban site. These are the ambiguous areas that are caught between enclaves. They may even be so extensive so as to constitute entire generic zones. These might be called *peripheral sites,* middle landscapes that are neither here nor there.

2. The second involves a fundamental paradigm shift from viewing cities in formal terms to looking at them in dynamic ways. Hence, familiar urban typologies of *square, park, district,* etc., are of less significance than the infrastructures, network flows, ambiguous spaces and other polymorphous conditions that constitute the contemporary metropolis. [7]

The design strategy proposed in the typology may have the capacity to increase its structural and programmatic capacity to support and diversify activities in time – even activities that cannot be determined in advance. Its importance lies in its ability to extend continuity while diversifying its range of services. [8] Rather than a fixed design strategy, the typology offers a framework for developing flexible uses as requirements change. A future analysis of the urban devices found within the typology may provide programmatic solutions to rebuilding, incorporating, connecting and intensifying generative architectural elements within the urban realm.

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Maria Kerkidou

Paper: **SPATIAL FORMATIONS OF INTERACTING AGENTS**

Topic: Architecture

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Abstract:
In contemporary architecture, the problematic of architectural design has expanded, and reshaped its boundaries through strategies that digital technology victuals. As a result, architects are inclined to revise the design logic and explore the architectural object while trying not to use programs but to program architecture per se. The shift towards an algorithmic expression of the architectural problem derives from the designer's need to codify the problem through a series of finite steps[1]. This work involves the designation of algorithms to generate form from the rule-based logic inherent in architectural briefs, typologies, even behavioural patterns that affect the organization of space. The implementation deals with the design of public open-air spaces. As such, it leads to the choice of a method able to provide for the demands of diverse users. Looking into the body of work of alternative methods investigating multi-user spaces, the use of agents constitutes an interesting and promising approach which has been frequently tested as observation and simulation platform of social behaviour[2]. Additionally, it is related to self-organization and incorporates concepts that attempt to decipher natural and social complex phenomena which determine their own form and processes. Based on these premises, this implementation brings into play two swarms of agents acting in parallel and representing i) the building components of an open-air space, and ii) the users along with their activities. The implementation algorithm is based on M.Resnick's 'Ant' model in which agents behave like ants, whose goal is, while navigating, to trace food, which they achieve by leaving trails of pheromone behind for someone else to find before the chemical evaporates. The ants' nests constitute the conceptual metaphor of a space's structural components, representing the environment; whereas the ants signify the users whose behaviour differentiates according to their activities. The system incorporates repelling/attracting forces changing the system's state, offering various snapshots of spatial configurations. The goal of the experimentation is to create a generic platform in order to provide a sketching tool facilitating and amplifying design creativity and expressiveness.

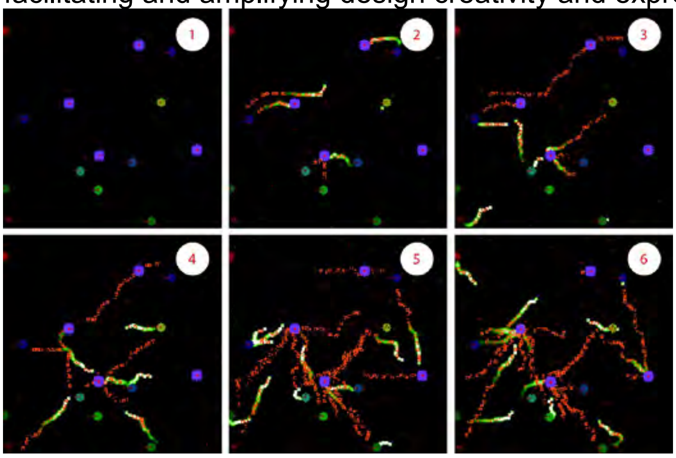

Image of agents' interaction: emergence of pheromone trails

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Keywords:
Emergence, agents, self-organization

Spatial formation of interacting agents

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The shift towards an algorithmic expression of the architectural problem derives from the designer's need to codify the problem through a series of finite steps. This work involves the designation of algorithms to generate form from the rule-based logic inherent in architectural briefs, typologies, even behavioural patterns that affect the organisation of space.

The implementation deals with the design of public open-air spaces. As such, it leads to the choice of a method able to provide for the demands of diverse users. Looking into the body of work of alternative methods investigating multi-user spaces, the use of agents constitutes an interesting and promising approach which has been frequently tested as observation and simulation platform of social behaviour.

Additionally, it is related to self-organisation and incorporates concepts that attempt to decipher natural and social complex phenomena which determine their own form and processes. Based on these premises, this implementation brings into play two swarms of agents acting in parallel and representing i) the building components of an open-air space, and ii) the users along with their activities.

The implementation algorithm is based on ant foraging models in which agents behave like ants, whose goal is, while navigating, to trace food, which they achieve by leaving trails of pheromone behind for someone else to find before the chemical evaporates.

The ants' nests, the food-sources retrieved and the nodes constitute the conceptual metaphor of a space's structural components, representing the environment; whereas the ants signify the users whose behaviour differentiates according to their activities.

The system incorporates repelling/attracting forces changing the system's state, offering various snapshots of spatial configurations. The goal of the experimentation is to create a generic platform in order to provide a sketching tool facilitating and amplifying design creativity and expressiveness.

1. Introduction

The application of computers in architecture has been confined so far within the boundaries of design and representational tools in architectural projects. Contemporary computer techniques offer the possibility of developing and handling new adaptive strategies embodied within the architectural process. Thus, this work refers to an enriched type of design that is bent on an adaptable version of architectural spaces and forms which respond not only to contextual parameters, but also to elements stressed out by the activities to be accommodated, within the frameworks of adaptive architecture.

The method which is chosen for the spatial formation stems from swarm intelligence systems and the computer model that has been developed is being based on relatively simple rules, resulting to a rather complex product compared to its initial elements. In spite of the inchoative structure of the model's system the final result can many times assist with problems of contradictory criteria.

Existing research on application of similar models has presented their analytical as well as generative aspect in terms of spatial tools and methods. Within the framework of this paper, both of the aforementioned aspects are schematically implemented and presented according to the current stage of the model-under-development allows.

This is part of an ongoing study developing a method which employs one swarm of agents as the building components of an open-air space (mobile or fixed) and another one as the users and their activities. There is interchange of data between the two swarms; namely, one group responds dynamically in every alteration of the other's state. The organisation of such a system integrates a mechanism of interaction which is based on a set of interrelations among its components.

2. Spatial interpretations and fluctuations

2.1 Spatial practice

Bill Hillier analyses explicitly that space should not be seen as the "inert background" of human's material subsistence. "Space is more than a neutral framework for social and cultural forms. It is built into those very forms. Human behaviour does not simply happen in space. It has its own spatial forms. Encountering, congregating, avoiding, interacting, dwelling, teaching, eating, conferring are not just activities that happen in space. In themselves they constitute spatial patterns" [1].

As Hillier suggests, the relation between space and act of living depends on the relations between configurations of people and configurations of space. Additionally, as Ireland puts it, the aforementioned spatial patterns are “not attributes of individuals, but patterns or configurations, formed by groups or collections of people” [2].

Doreen Massey’s work theorizes about the abstraction of space and contrives to present its attributes through the following considerations:

1. Space can be recognized as the product of interrelations: “as constituted through interactions, from the immensity of the global to the intimately tiny” [3].

2. Space can be understood as the sphere of the possibility of the existence of multiplicity in the sense of contemporaneous plurality: “as the sphere in which distinct trajectories coexist; as the sphere therefore of coexisting heterogeneity. Without space, no multiplicity; without multiplicity, no space. If space is indeed the product of interrelations, then it must be predicated upon the existence of plurality. Multiplicity and space as co-constitutive” [3].

3. Space can be identified as continuously under construction: “Precisely because space is a product of relations-between, relations which are necessarily embedded material practices which have to be carried out, it is always in the process of being made. It is never finished; never closed. Perhaps we could imagine space as a simultaneity of stories-so-far” [3].

Extending this analytical approach, De Certeau’s notion of space is introduced as the composition of mobile elements’ intersections. “A space exists when one takes into consideration vectors of direction, velocities, and time variables. Thus space is composed of intersections of mobile elements. It is in a sense actuated by the ensemble of movements deployed within it. Space occurs as the effect produced by the operations that orient it, situate it, temporalize it, and make it function in a polyvalent unity of conflictual programs or contractual proximities. Space is a practiced place [4].

While reflecting on the aggregation of the above theories, one discerns the importance of space’s aptitude to transform, not being identified as the object space but as the spatial formulation articulated through movement, activity, habitation and interaction [5].

2.2 Spatial production

In terms of design, a multitude of parameters must be integrated and embodied through the form-finding process. Additionally, the design of space requires the incorporation of complex organisational and functional necessities; and therefore “constitutes a recurrent negotiation of analyzing existing and requisite conditions as well as generating and evaluating possible responses” [6].

Further to this recognition, M. Hensel and A. Menges enhance architectural design with the properties of versatility and vicissitude; versatility dealing with “the notion of the behaviour and performance of an organism or artifact within its specific context, while addressing both the object and the subject", and vicissitude entailing "the differentiation of the object and the dynamic of the environment" [7].

Moreover, from the aspect of the design process, the parameters that compose the design problem of space, in spite of the conventions and abstractions of representation, acquires the properties of space, and thus, inherits its complexity. Thereupon, the articulation of the functions that outline the architectural program is also complex. It is corroborated that space being defined through the -soon to be assigned- utility and hence, activity, shows evidence of organisational dynamic characteristics.

Such an approach argues that diverse social interactions are ascribed by the "motile, mutable and feedback-based relations between habitat and inhabitants", for which the articulation of the built environment acts as a supporting layer with catalytic features. Subsequently, inhabitants' activities can be identified as emergent equivalents of "individual and collective itineraries, with provisions made and conditions yielded by highly differentiated spatial organisation and material systems" [7].

3. Synthesis of space through agents

The intention of this research is the development of a method that bridges the perception of space and the deployment of architectural design. In order to define the notion of space within the framework of habitation, interaction and activity, it is aspired to assemble the emerging attributes through computational methods that invoke interpretations and approaches of natural systems as an attempt to translate information into object. It is not intended to simulate human behaviour, but to investigate how behavioural patterns of usage and habituation of space can be produced through simple interaction among discrete entities and how this systemic structure can compose a morphogenetic matrix of spatial articulations and configurations.

According to Asquith [8], spatial behaviour allocates perpetually changeable features depending on the general context, resembling the rules conditioning social insects' behaviour, whose local interactions expedite emerging behaviours of global range; thus, stressing out the aptitude of self-organisation systems.

"The specificities of space are a product of interrelations -connections and disconnections- and their (combinatory) effects" [9]. Assembling the characteristics of space one can discern the reasons for which the agent based approach is chosen for this implementation.

Agent based modeling comprises a theoretical basis along with practical instruments which combined can offer an interesting aspect of natural and urban phenomena as a collective dynamics of interacting components. Agents facilitate the investigation of the individual's behaviour in micro-level associated to the patterns that emerge through the interplay of numerous individuals in macro-level [10].

Specifically, this work implements a simulation using swarm intelligence. The definition of swarm intelligence would describe the attempt to design algorithms or distributed problem-solving mechanisms that collect information from the collective behaviour of social insects, offering an alternative way of creating intelligent systems [11].

Swarm intelligence is based on two fundamental concepts: self-organisation and stigmergy. Self-organisation constitutes a process during which the global tuning of the system rises through local interactions among its components. Stigmergy complements self-organisation, describing the way of communication and interaction between the components of the system.

Extending this to artificial intelligence entails that agents can respond to disturbances without being programmed to manage the specific disturbance [11]. As James Adam describes, “the simple building behaviours of each individual, acting alone, combine together and result in the construction of coherent, functional structure”. There is no activity coordinator as a unit, but rather a collective intelligence expressing the aggregate of the colony [12].

As a result, while the individual actions of each insect can be described very simply, emergent behaviour appears, that is, when many individuals are working simultaneously in the same environment, the behaviour of the system as a single entity is seen to the construction of a complex structure. This behaviour stems from the individual actions of each insect [12].

4. Design problem and method

The implementation presented is addressing the design problem of open-air multi-use space such as a park. The programmatic demands deal with the fact that this kind of space addresses a broad spectrum of users from diverse backgrounds.

Principal goal is to assign to space transformative features as response to the continuously changing conditions that affect open-air spaces (e.g. weather conditions), as well as to the diverse demands of the users (e.g. sight-seeing visitors or everyday visitors).

The platform used for this implementation is NetLogo which constitutes a multi-agent programmable modeling environment (fig. 1). It offers the ability to model complex systems unfolding through time easily and effectively, along with the use of numerous agents that act independently, enabling the study of micro-behaviour of individuals as well as the macro-patterns emerging from their interaction [13].

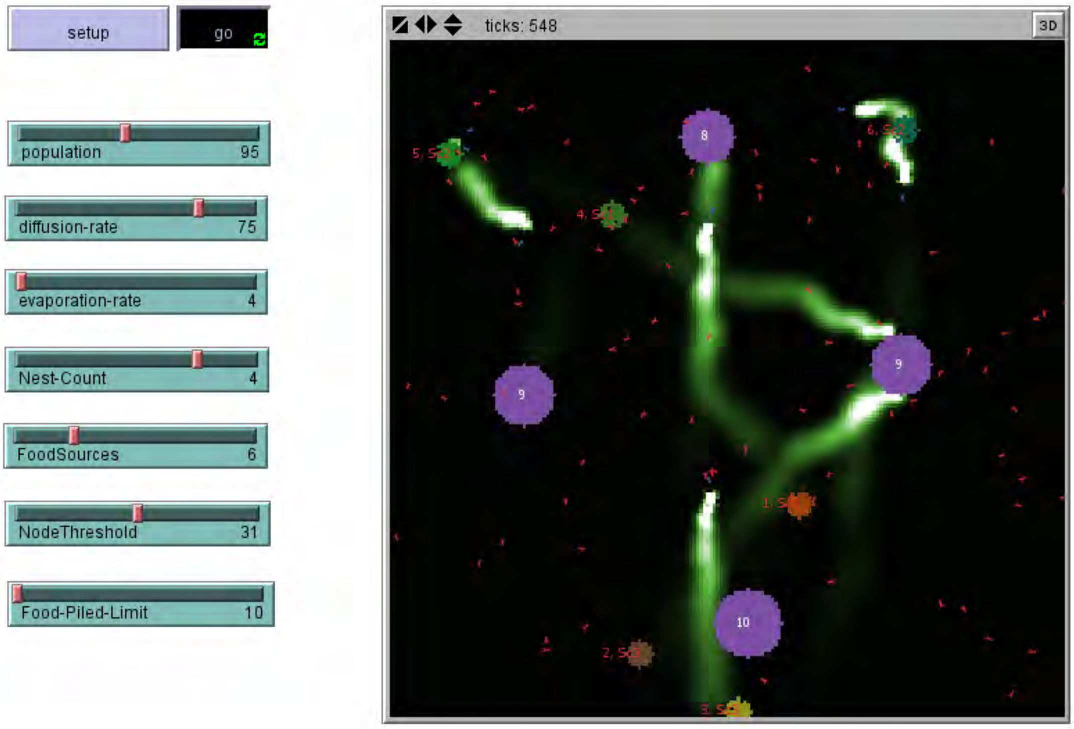

Figure 1: Model interface.

The model incorporates two groups of agents that act in parallel. The one group represents the users of space/pedestrians (ants) while the second one the environment (patches: surface units of the 'wolrd') (fig. 2).

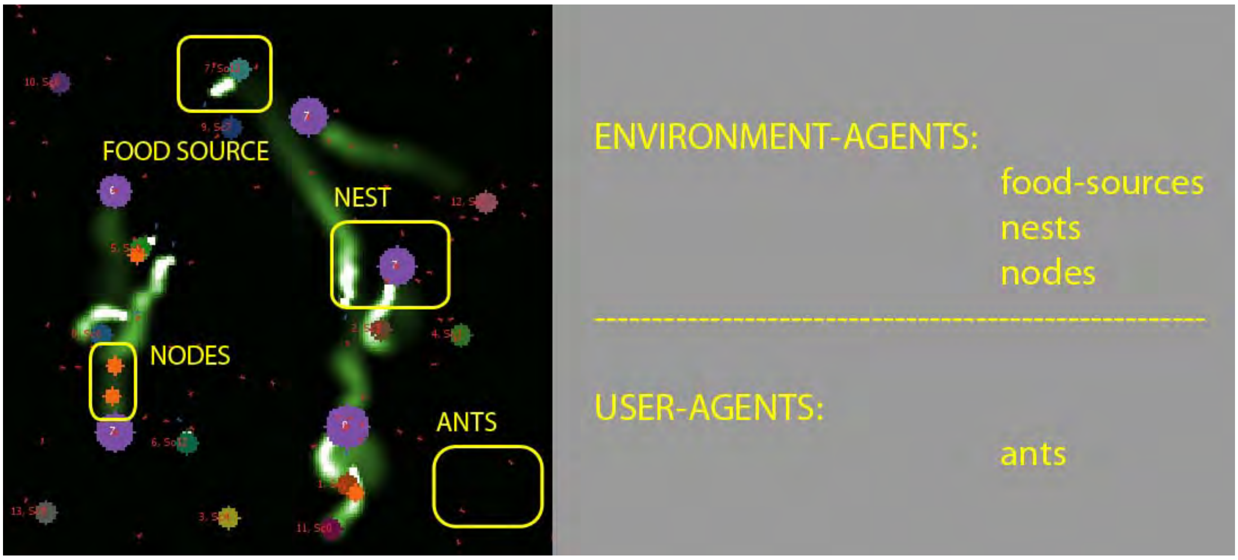

Figure 2: Environment-agents in various forms (food-sources, birth-nests, nodes) surrounded by user-agents (ants in red and blue according to their quest status) navigating the 'world'.

Collective behaviour is achieved through the application of chemical substance release (pheromone), which is used to indicate destinations. Destinations conform to each ant's food preference and constitute diverse food sources, whose discovery signals the release of pheromone, marking a trail.

The existence of the trail gradually deteriorates through evaporation, while the rest of the ants that share the same food-preferences (hence, interest in reaching the same destinations) will follow towards the location pointed by the trail. During their journey back to their birth-place (nest of route's initiation), ants become at some point aware of the nest's location inside the 'world' of patches. In actual ant behaviour this is achieved through the recognition of landmarks via comprehension of polarized light, whereas in this simulation model, it is achieved through scent emission by the nests throughout the 'world' in a gradient intensity. In this case, birth-nests as well as food-sources represent activities that engage the agents and therefore, cause their movement or lingering around the reason of attraction. Their location is set on random coordinates of the 'world', subject to the restriction not to approximate each other more than a certain number of patches.

Food-sources are labeled in order to indicate their identity to the observer, which is consistent to their 'scent'. This scent belongs either to a list of the food-sources that attract an agent (Attract List), or to the list of those that repel him (Repel List). The agents define their direction based on the scents and chemicals that are possibly stored at their neighboring patches' log. Scents originate from nests and food-sources, while chemicals derive from trails of other agents. Therefore, agents' communication is achieved indirectly, through the interaction among the patches and the agents who are located in short range.

Upon the discovery of an interesting patch, the agent, apart from examining thoroughly whether there are scents that belong or not to his list of preferences, he also calculates whether a scent's intensity outweighs the rest of the traced elements. If the indicative values show that a repeller surpasses an attractor or there are only repelling forces, then the agent ignores the stimulating source; if the attractor surpasses the repeller or there are only attracting forces, then the agent acquires heading towards the attracting source. In a similar way, the agent is checking the adjacent patches left, right and ahead in order to grasp where exactly the alert comes from and whether it is valid.

Once the food-source is traced, the agent subtracts a food-unit from the source's stock and starts to release pheromone starting his journey from the food-source to the birth-nest. Eventually, this process leads to the obliteration of food-sources which, as an integrated metaphor of the model, represents the activities (disguised as food-sources) of a specific duration which in due course, stop existing.

Trails are formed following the agents' released chemical substance which slowly evaporates and spreads out to the neighboring patches. Numerically, the diffusion and evaporation rates are defined by the program user. Throughout the program's application, nodes appear in the form of orange aggregates of patches.

Nodes constitute a response of the context to increased concentration of pheromone indicating much frequented sections of paths or junctions of many paths. The appearance of nodes is of short duration, unless reappearance occurs due to heavy traffic in trails. Their signification refers to possible places hosting new activities that can be linked with peak hours of circulation.

Another feature suggesting adaptability to the system's alterations is the nests' expanding growth, which is analogous to the food imported by the ants of the respective nest. The size of the nest changes within predefined limits, manifesting the success rate of the ants' quest. In terms of design concept, the responsive nests signify the aggregation of activities and gathering of many users, suggesting more permanent locations for the tested hosting spaces (fig. 3).

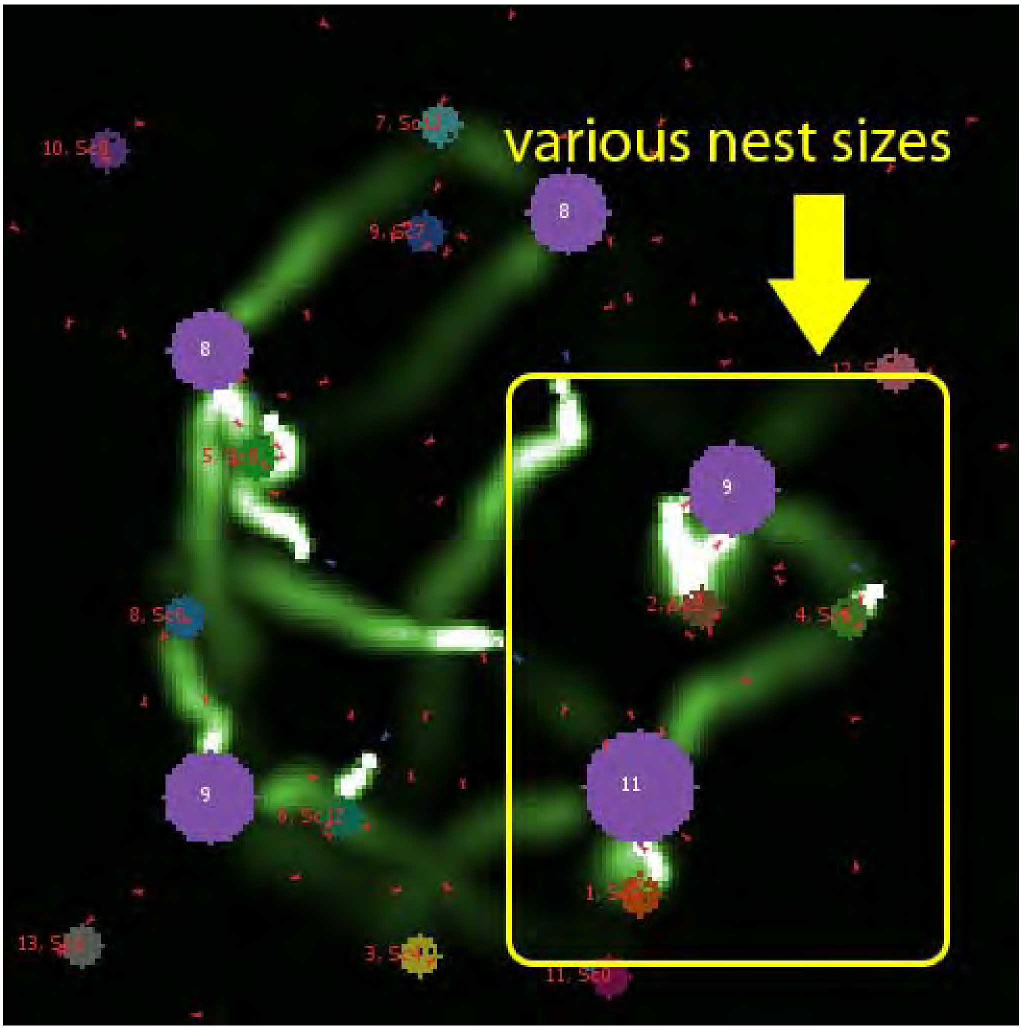

Figure 3: Gradual growth of nests based on the colony's success to trace and carry food back to the nest.

The emergent trail network which is produced is based on the feedback relationship among pheromone, diffusion, evaporation and agents' behaviour.

The emission of pheromone by one agent affects many others that gravitate to the trail. Should their list of preferences coincide with the traced chemical, then additional pheromone release reinforces the trail.

Through diffusion, more agents become interested to certain paths, resulting to a route formation among food-sources and nests (fig. 4).

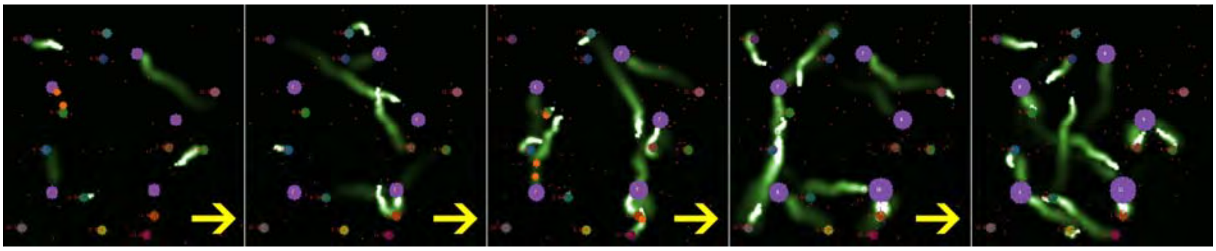

Figure 4: Sequence of time steps after the initiation of the model.

Linking those activity-imbued spaces, puts on the map their location and establishes, as time passes, stronger connections which surpass the predefined threshold of intensity being indicated by nodes [14].

The principle variables of the model manage the tuning of the system and its responsiveness according to:

1. number of agents which is defined by the population of ants; number of nests (Nest-Count)
2. diffusion-rate which specifies the amount of pheromone which is distributed from one patch to its neighboring ones
3. evaporation-rate which defines the amount of pheromone that patches drop at each time step
4. node threshold which defines the amount of pheromone that one patch must in order to become a node

As a result, a dynamic model gives rise to emergence stemming from agent interaction with the environment in adaptive terms. The fluctuation in the behaviour of the agents, exhibits great relevance respectively with the behaviour of biological systems, as in both cases self-organisation and emergence is achieved.

The results demonstrate a dynamic methodology towards the creation of spatial and route configurations whose network develops in several directions and thus, from an architectural point exhibits interesting spatial formations.

5. Conclusions

The model presented elaborates on the conceptual approach of architectural and spatial synthesis via agent based systems. Among the objects of research is to investigate whether spatial configurations can integrate diversity of behavioural singularities. The proposed method stems from a research in its schematic phase, and its structure is still under development in generic form allowing for additional features to be included in the future.

The model demonstrates a dynamic system whose flexibility and adaptability can be an asset if used in early stages of design process. User-agents circulate and stimulate their context causing alterations to the behaviour of environment-agents, promoting interaction and triggering a dynamic process to evolve. The system's state is modified as the local parameters, affected by movement, change the environment's configuration, forming paths among the several activities that endure or not in time. Successively, contextual stimulus causes alterations on other agents, who also respond at a subsequent time changing their movement; forming altogether a system in constant flux. The feedback process between user-agents and environment-agents is ongoing and gives rise to spatial configurations that emerge dynamically while being subject to the prevailing conditions of the environment.

The geometry of the model is abstract as it emerges from movement's traces, empty areas and spaces of activities, apt to be further ameliorated. In terms of representation, the model could also extend its geometrical vocabulary to architectural forms. This enhancement could also include a closer inspection of the interconnections among the system's components as to how this structure can be ascribed into spatial organisation. Development of the model towards purpose will entail the incorporation of further features; such features may comprise statistical data, classification of groups, exogenous perturbation factors etc.

Acknowledgments

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Paper : **FROM LABYRINTHS AND RECURSIVE FOLDS TOWARDS GENERATIVE ARCHITECTURE**

Topic: Architecture

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Abstract:
On a pillar of the portico of Lucca Cathedral is carved a «digital» labyrinth, i. e., a labyrinth that is to be followed by the mean of a finger.
This labyrinth, as all those found in medieval churches (which are borrowed from those depicted in antiquity) is a unicursal (non-branching and without dead ends) path, that leads without ambiguity from the entry towards the centre.
Such a classical labyrinth may be considered as a folded line that tends to be of a maximal length in a definite area, i.e. a line (1D) that tends to fill a part of a surface (2D), and thus may be linked to FASS (space-**F**illing, self-**A**voiding, **S**imple and self-**S**imilar) curves, and other recursively folded curves.
This paper discusses issues involved in labyrinths as well as FASS curves, and in the relationship between them.
Then it explains ways to make labyrinthine FASS curves or other recursively folded curves, especially through edge-rewriting and node-rewriting L-systems, in different spaces (2D, 3D or fractal) and various shapes.
Finally, implications and uses of the labyrinth, and its extrapolations, in generative architectural design are suggested and explored.

Finger labyrinth in Lucca Cathedral

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Keywords:
labyrinth, FASS curves, L-systems, folds, generative architecture

From Labyrinths and recursive Folds towards generative Architecture

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Abstract

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Then it explains ways to make labyrinthine FASS curves or other recursively folded curves, especially through edge-rewriting and node-rewriting L-systems, in different spaces (2D, 3D or fractal) and various shapes.
Finally, implications and uses of the labyrinth, and its extrapolations, in generative architectural design are suggested and explored.

1. Labyrinths

1.1 What is a Labyrinth?

In any language, the current meaning of the word *labyrinth* suggests some complex structure, through which it is difficult to find one's way, and from which it is difficult to escape. The streets of a medieval town or the corridors of a complicated castle are said to form a *labyrinthine* network. Metaphorically, a nightmarish situation in which one has to find one's way through abstruse rules, knocking on non-opening doors, puzzling on unanswered questions, like Joseph K. in *The Trial* [1], is qualified as *labyrinthine* as well. According to this colloquial use of the term, a labyrinth would be a *multicursal* (i. e. branching, with dead ends and even loops) pattern of paths.

Fig. 1: Finger labyrinth in Lucca

However, such is not the labyrinth engraved on a pillar of the portico of Lucca Cathedral (Fig. 1). Its path, meant to be followed by the finger (and which is not the engraving itself, but is defined by it), is *unicursal*, leading without ambiguity from an entry at the right of the perimeter towards the centre. The way back out of the labyrinth poses no problem, and there would be no need of a thread to find it. Its pattern is identical to most ones of medieval labyrinths, of which the one in Chartres Cathedral is an archetype (Fig. 2).

Fig. 2: Chartres labyrinth

Most are, like the Chartres one, pavements on the floor, and probably meant to be followed by pilgrims on their knees.

Practically all of those medieval labyrinths have the same pattern, which is the one drawn by Villard de Honnecourt himself (Fig. 3). Most are circular patterns, though octagonal or even squared variants may be found.

Fig. 3: Sketchbook of Villard de Honnecourt (about 1230)

The reference to the myth of the Minotaur in medieval patterns, even when it is not explicit as in Chartres, where a copper plate depicting Theseus, Daedalus and the Minotaur was in the centre of the labyrinth), is obvious and well documented. The medieval labyrinth pattern itself is however different from ancient labyrinth patterns like those shown in Figs. 4, 5. This pattern is mostly round, though there are some squared ones, like the earliest recovered one, incised on a clay tablet from Pylos (Fig. 4).

Fig. 4: Labyrinth incised on clay (Pylos, Greece)

Fig. 6: Cretan coin (British Museum)

That is the same ancient pattern that is used in Scandinavian so-called «Troy Towns», which are medieval labyrinths made of stones (Fig. 7), dated from as far back as the 13th century.

Fig. 7: «Trojeborg», or «Troy Town», a stone labyrinth (Sweden)

In both (ancient and medieval) cases, a labyrinth is a pattern that defines a unicursal path, but it must be noticed that in any case what is drawn, engraved, built, and so on, is the pattern of «walls», i.e. the pattern (which is itself multicursal) from which the path, sometimes called «Ariadne's thread» (though one does not need a thread to find one's way out) is deduced. This path runs around the centre (with twists) a certain number of times, called rings. The number of rings differentiates variants of the pattern from one another. The classical ancient pattern comprises 7 rings (Fig. 8), while the medieval one is made of 11 rings (Fig. 9).

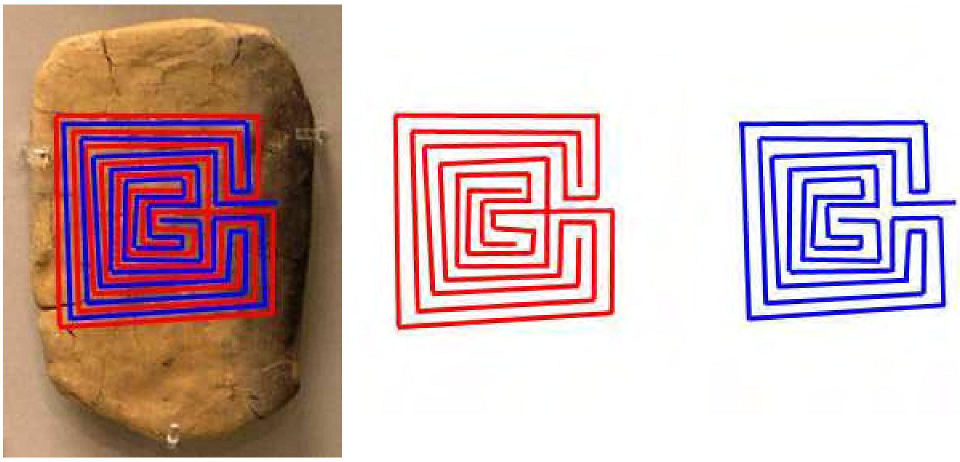

Fig. 8: Walls and path of the ancient labyrinth

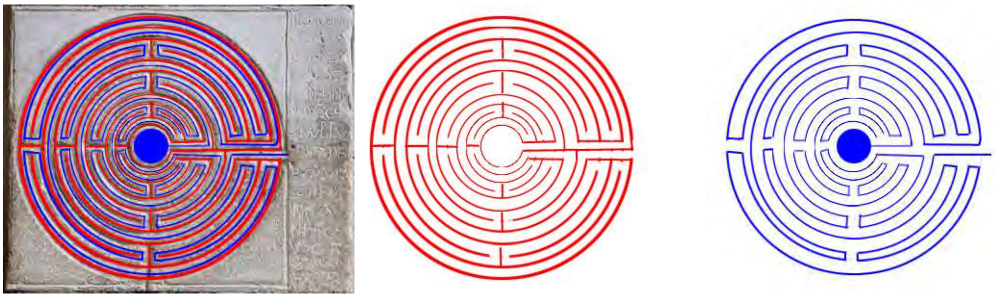

Fig. 9: Walls and path of the medieval labyrinth

One may notice that all these patterns (of walls) show a straight wall that goes from the perimeter towards the centre. In all those patterns the path begins on one side of this radial wall and ends on the other one. From this wall emerge two «branches», right across each other for the ancient pattern, shifted for the medieval one. This observation leads us to the construction of the labyrinth.

1.2 How to construct a Labyrinth

Hermann Kern, in his «bible» of the labyrinth [2], explains how to construct a 7-ring ancient pattern of labyrinth. You start with a cross, and you draw L shapes inside the corners of that cross, and put a dot inside each L. Then, the process is very straightforward: you join the top of the cross with the top of the L at its left, and you join what you find following on each side, making some round ring around the pattern in progress. That is how you obtain a 7-ring ancient labyrinth pattern (Fig. 10)

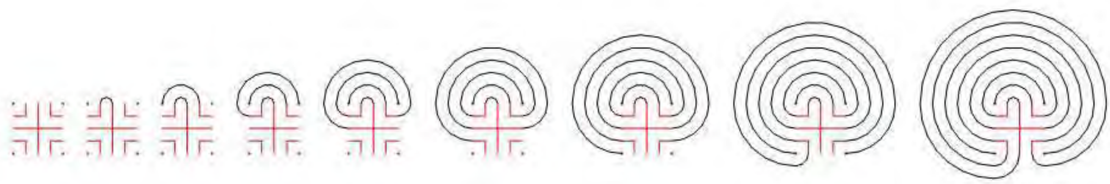

Fig. 10: Construction of the 7-ring ancient labyrinth

Variants with 3 or 11 rings are produced by eliminating the Ls or doubling them respectively (Figs. 11,12). You can get two variants of 5 (resp. 9) rings by eliminating (resp. doubling) the top Ls or the bottom ones (Fig. 13)

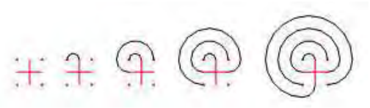

Fig. 11: Construction of the 3-ring ancient labyrinth

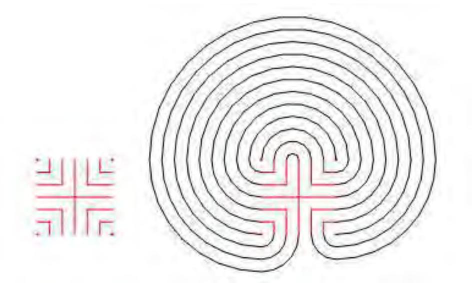

Fig. 12: First and last steps of the construction of the 11-ring ancient labyrinth

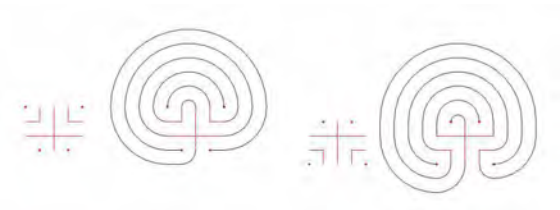

Fig. 13: Construction of the two variants of a 5-ring ancient labyrinth

All those patterns consist of an odd number of rings. Such are indeed most, or maybe all, of the labyrinths actually found. But the method described above may lead to even numbers rings. One has simply to eliminate one L in the starting scheme of any of the schemes already used. This leads to patterns in which the path begins and ends at the same side of the radial wall.

In that way, we could obtain a series of patterns, with 1, 2, ..., n rings.

We have noticed before that the perimeter of the ancient pattern is not a circle, but rather some sort of spiral. One step towards the medieval pattern is to «circling» the ancient pattern, and to slightly change the method, by starting with a «cross» with shifted arms, and drawing parts of concentric circles when joining dots. That is not a medieval pattern yet, but it is this pattern that we shall use in our further experimentations.

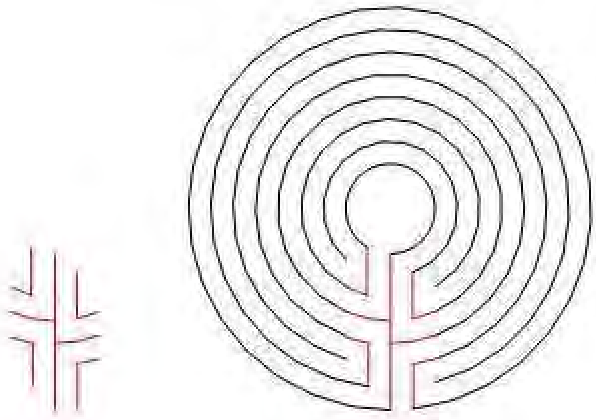

Fig. 14: Construction of the 7-ring ancient pattern, with rings on concentric circles

The medieval pattern is more elaborated: it has got partial radial walls in three other directions, blocking two rings at a time, and forcing the path to turn back. But by replacing the Ls by some sorts of «double» Ls, and inserting radial barriers at the right places, we can deduce the construction of the 11-rings medieval pattern from that of the 7-rings ancient pattern.

1.3 Generating the labyrinth

The presence of the radial wall lets us «cut» the pattern and imagine that we «spread» it, in order to obtain a rectangular pattern (Fig. 15). That transformation may be geometrically expressed as a change of coordinates, from polar coordinates, to euclidean ones.

Fig. 15: Spreading the 7-ring ancient pattern

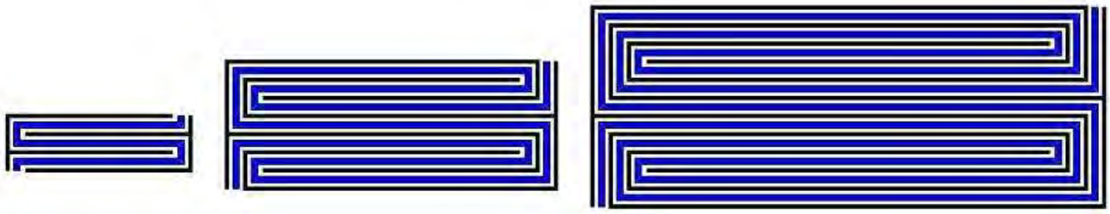

Fig. 16: Spread 3, 7, and 11-ring ancient patterns

This representation of the labyrinth pattern, and especially of its path, lets us better understand what is actually a labyrinth. It has been said that a labyrinth is not a meander (also called «Greek key»), but the unfolded path of the classical ancient 7-ring labyrinth clearly shows a double meander. The meander is not a spiral, but it is in a way a «double» spiral, a spiral that enters doubled by a spiral that goes out.

Spread out, and so in a way unfolded, the labyrinth path is still a folded line, and even a recursively folded line. The progression in the number of rings lets us imagine a process in which we would write a rule of transformation to get from pattern to pattern.

Considering the meander, one can translate its progression by this L-system:

L-system #1
V={X,A,B,F,+,-}
ω : B-X+B
X → AFFF-A-X+A+AFFF
A → AFF
B → AF
F → F

The interpretation of the symbols is as such:
A, B, F : move forward (and draw a line)
X : move forward (and draw a line) three steps
+ : turn left
- : turn right

The length of each step is the same, the angle is 90°. Steps 1 to 5 of the derivation are shown in Fig. 17.

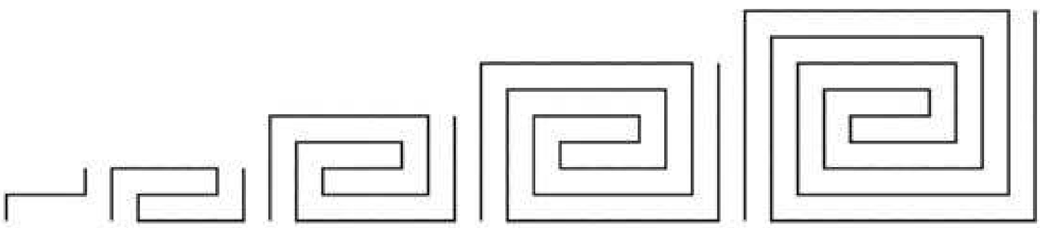

Fig. 17: Steps 1 to 5 of the derivation of L-system #1

The ancient pattern is made of two meanders, its 3, 7 and 11-ring variants may be easily deduced from the three first step of this L-system.

One can also spread out the medieval path pattern. Unfortunately it is difficult to translate this pattern into some sort of L-system. Anyway this pattern reminds us of some of those encountered in FASS curves.

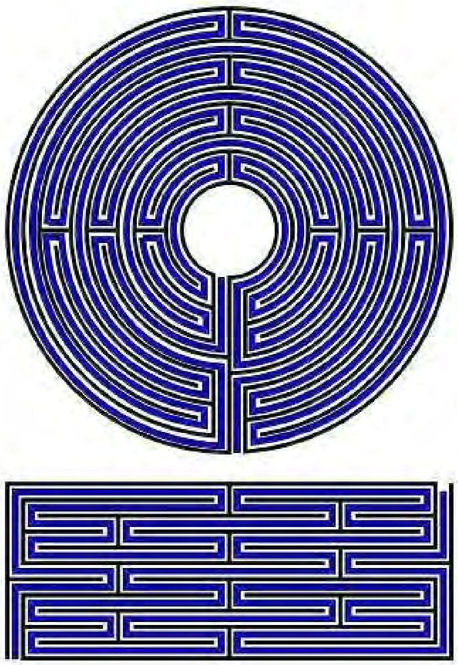

Fig. 18: Spreading the medieval pattern

2. FASS curves

2.1 What are FASS Curves?

FASS (space-**F**illing, self-**A**voiding, **S**imple and self-**S**imilar) curves have been known as early as the end of the 19th century, and belong to that «gallery of monsters» Mandelbrot refers to when he is forging his fractal theory [3]. The most known ones are the Hilbert curve (1891) and the Peano curve (1890).

The aim of those mathematicians was to exhibit paradoxical objects, in order to prove that what some of their colleagues thought impossible, was actually existing. They exhibited curves (dim. 1) that could be assimilated to surfaces (dim. 2), as they pass through every point of them and contributed as such in the set theory regarding issues of dimension and infinite.

Some of those mathematical paradoxical sets were obtained by recursive holes through a segment (Cantor set, 1883), a triangular surface (Sierpinski gasket, 1915), a cube (Menger sponge, 1926). What characterises Hilbert and Peano curves, and all FASS curves imagined since those forerunners, and links them to the labyrinth, is that they are r*ecursive folds*.

2.2 How to get FASS Curves by L-Systems

FASS curves inscribed in a square may be considered as edge-rewriting or node-rewriting L-systems [4]. In any case, one must take care of the definition of such a curve, as a finite, *self-avoiding* approximation of a curve that passes through *all* points of the square.

In edge-rewriting L-systems, one has to consider the square recursively divided into 2 x 2, 3 x 3, 4 x 4, or more generally n x n tiles, and to find a path through all the points of the initial grid. This path must be self-avoiding, but the replacement of each tile by this path must also yield a self-avoiding line.

As it is an edge-rewriting system, the start and end points of the initial path must be at adjacent vertices of the square. Once the path is found, one has to consider its inverse, and to replace each edge by the initial path or its inverse, depending on the side on which the replacement must take place. By experimenting with 2 x 2, 3 x 3 or 4 x 4 tiles the exploration of all possible paths shows that the condition of being self-avoiding (the path must not touch itself neither by an edge nor by a node) is not reachable.

Actually, it has been demonstrated that the simplest FASS curve obtained by edge replacement in a square grid is the so-called E-curve, which requires a 5 x 5 grid.

In node re-writing systems, one has also to consider a tiling of the square, but as it is the node, and not the edge, which will be replaced, one can consider either a path that links two adjacent vertices of the initial square, or two diagonally opposed ones. The chosen n x n grid leads actually to a n+1 x n+1 tiling, because that is the nodes that are replaced, and there are one more node than edges (on the side of the initial grid).

For the simplest grid we can imagine (1 x 1), there is only one way to find a path through the four vertices of the square, a U path, and it links two adjacent vertices of the square (there is no way to link the diagonally opposed ones, obviously). Once one has determined the left and right position of each replacement, the corresponding L-system is straightforward.

L-system #2
V={L,R,F,+,-}
ω : L
L → +RF-LFL-FR+
R → -LF+RFR+FL-
F → F

The interpretation of the symbols is as such:
F : move forward (and draw a line)
L and R are not interpreted but only derived
+ : turn left
- : turn right

This simplest FASS curve is actually the Hilbert curve mentioned above.

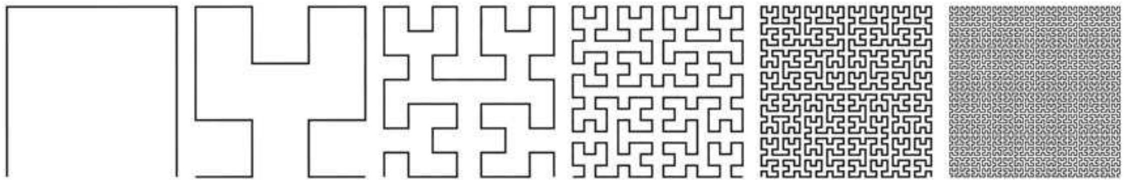

Fig. 19: Steps 1 to 6 of the derivation of L-system #2 (Hilbert curve)

Now, starting from a 2 x 2 grid, there are only two possible paths, the first one being a S path linking tow opposite vertices. This node-rewriting L-system leads to the Peano curve mentioned before.

L-system #3
ω : L
L → LFRFL+F+RFLFR-F-LFRFL
R → RFLFR-F-LFRFL+F+RFLFR

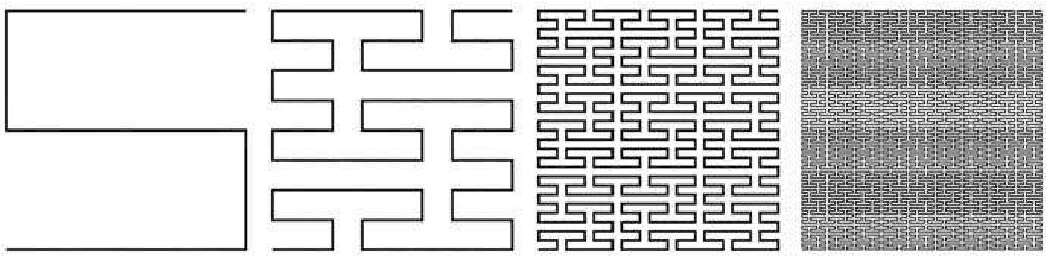

Fig. 20: Steps 1 to 4 of the derivation of L-system #3 (Peano curve)

The other path, linking two adjacent vertices of the square, leads to the other FASS curve shown in Fig. 21.

L-system #4
ω : L
L → LF+RFR+FL-F-LFLFL-FRFR+
R → -LFLF+RFRFR+F+RF-LFL-FR

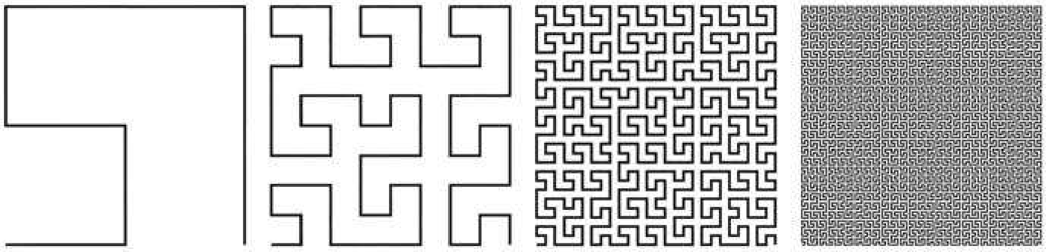

Fig. 21: Steps 1 to 4 of the derivation of L-system #4

Considering the subdivision of the square into more tiles, we can generate many other FASS curves. Among them, one is especially interesting for our topics, as it begins with a path through the 4 x 4 square which is actually a meander (Fig. 22)

L-system #5
ω : L
L → LFRFLFRFL-F-R+F+L-F-RFLFRFL-F-RFLFR+F+LFRFLFR+F+L-F-R+F+LFRFLFRFL
R → RFLFRFLFR+F+L-F-R+F+LFRFLFR+F+LFRFL-F-RFLFRFL-F-R+F+L-F-RFLFRFLFR

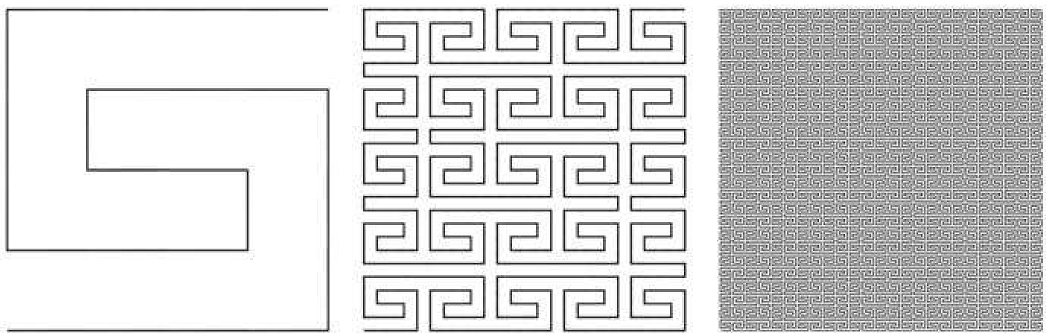

Fig. 22: Steps 1 to 3 of the derivation of L-system #5

2.3 Transforming FASS Curves into Labyrinths

A first comment we can make when looking at those FASS curves and comparing them to the labyrinth path patterns, is that the tiling entails some round-turnings, which would correspond to intermediate «walls» in terms of labyrinth patterns. Except for their first derivation, they are then essentially different from the ancient labyrinth pattern.

On another hand, classical labyrinth patterns, and especially the medieval archetypal pattern, involve that the path begins on one side of the separating wall and ends on the other, which corresponds for the FASS curve scheme to a path that links diagonally opposed vertices of the initial square.

Anyway, one can imagine new labyrinths by doing the inverse operation we did in spreading out the labyrinth in 1.3. This transformation (which acts on a bitmap representation of the FASS curve) changes the coordinates from euclidean to polar.

Using some representation of step 2 of the Peano curve (see Fig. 20), and transforming it, we obtain something that could be followed like the finger labyrinth in Lucca.

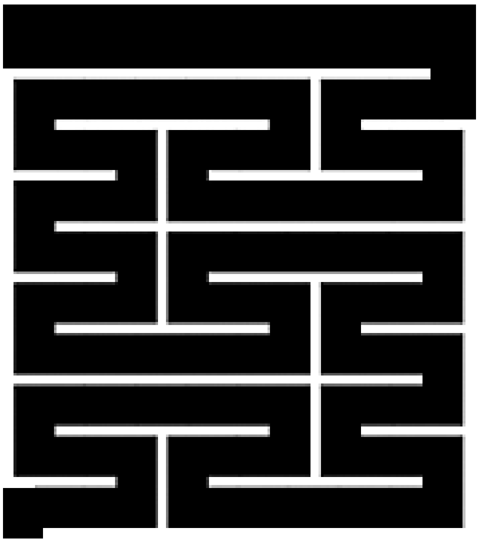

Fig. 23: A representation of step 2 of the Peano curve

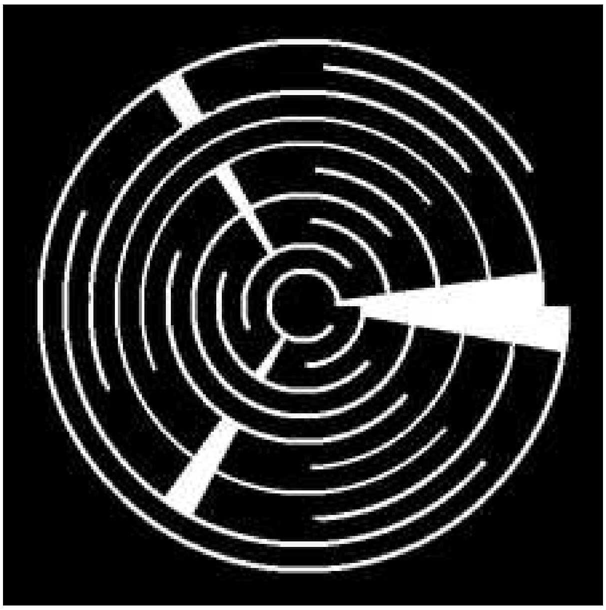

Fig. 24: Transformation of Fig. 23 through a change of coordinates

Fig. 25: An interpretation of Fig.24 as an engraved stone

3. Provisional conclusions and further questioning

A labyrinth is a path, a route, and some authors ascribe its origin to a ritual dance. The *path* is one of the interpretations of the line, the other one being the *limit* (the border of a surface).

We can see two fundamentals characteristics of the labyrinth as a path that links the perimeter of a shape to its centre: it is a mean of disorientation, and it is a way of putting a very long path inside a bounded area.

The labyrinth is not a spiral, it changes often of direction and then tends to disorient the traveller. It moreover offers a deceiving hope of reaching the aim, as it diminishes and increases the distance from the centre all the time. In the medieval pattern, one reaches the ring nearest from the centre very soon, and has to go on the farthest at the end of his travel.

The labyrinth as a way to put a very long path inside a relatively small surface is illustrated by the length of the Chartres labyrinth (261.55 m) inscribed in a circle of diameter 16.40 m.

The labyrinth is one of the fundamental myths of origin for architecture, and Daedalus, its inventor, is said to be the father of all architects.

Leaving apart the ambiguity of the definition of the labyrinth, one may wonder why a labyrinth, which is fundamentally a path, is so important in architecture. There are actually cases in which the path is the essential part of a design. One can think of the pattern involved in such Swedish furniture store, or, more architecturally interesting, of a museum.

Le Corbusier chose the spiral for his «Musée à croissance illimitée» (1939), but he could have explored some form of labyrinth.

Frank Lloyd Wright also chose the spiral for the Guggenheim Museum (1959) in New York, or rather an helix, as the spiral rises up.

The labyrinth is fundamentally a 2D pattern, distinct from the interlace, which, even if it is drawn on a plane, supposes a third dimension. However, one can try to imagine what the labyrinth concept means in 3D, by relating to FASS curves. In order to conceive such 3D FASS curves, one has to find a path passing through all the vertices of a 3D grid dividing the cube.

For instance, in the same way as the Hilbert curve fills a square, a very well known FASS curve fills a cube. This Hilbert 3D curve is shown Fig. 26.

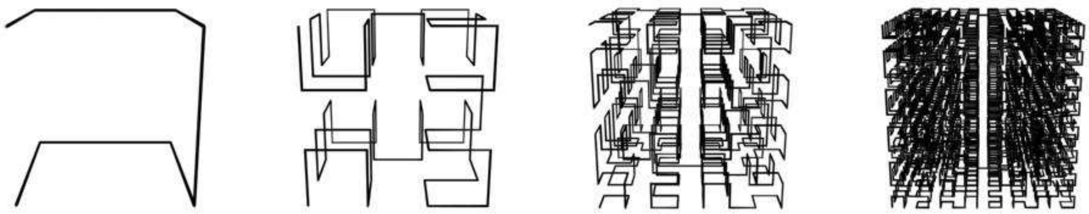

Fig. 26: 3D Hilbert curve

One line of further questioning would be about a possible 3D transposition of the labyrinth.

But, more essentially, the importance of the signification of the labyrinth in architecture should be detected and questioned.

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Paper : **Animated Music: Early Experiments with Generative Art**

Topic: Animation

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Abstract:
This paper will explore the historical underpinnings of early abstract animation, more particularly attempts at visual representations of music. In order to set the stage for a discussion of the animated musical form, I will briefly draw connections to futurist experiments in art, which strove to represent both movement and music (Wassily Kandinsky for instance), as a means of illustrating a more explicit desire in animation to extend the boundaries of the art in terms of materials and/or techniques

By highlighting the work of experimental animators like Hans Richter, Oskar Fishinger, and Mary Ellen Bute, this paper will map the historical connection between musical and animation as an early form of generative art. I will unpack the ways in which these filmmakers were creating open texts that challenged the viewer to participate in the creation of meaning and thus functioned as proto-generative art. Finally, I will discuss the networked visual-music performances of Vibeke Sorenson as an artist who bridges the experimental animation tradition, started by Richter and Bute, and contemporary generative art practices.

This paper will lay the foundation for our understanding of the history/histories of generative arts practice.

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Keywords:
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Animated Music: Early Experiments with Generative Art

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Premise

This paper will explore the historical underpinnings of early abstract animation, more particularly attempts at visual representations of music. In order to set the stage for a discussion of the animated musical form, I will briefly draw connections to futurist experiments in art, which strove to represent both movement and music (Wassily Kandinsky for instance), as a means of illustrating a more explicit desire in animation to extend the boundaries of the art in terms of materials and/or techniques. By highlighting the work of experimental animators like Hans Richter, Oskar Fischinger, and Mary Ellen Bute, this paper will map the historical connection between musical and animation as an early form of generative art. I will unpack the ways in which these filmmakers were creating open texts that challenged the viewer to participate in the creation of meaning and thus functioned as proto-generative art. Finally, I will discuss the networked visual-music performances of Vibeke Sorenson as an artist who bridges the experimental animation tradition, started by Richter and Bute, and contemporary generative art practices. This paper will lay the foundation for our understanding of the history/histories of generative arts practice.

Animated Music: Early Experiments with Generative Art

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“When situated as a deep-time project, history becomes a discovery process with open-ended results and multiple points of entry. If we consider the convergence of technology and the expansion of cinematic arts, the opportunity for new forms and new voices increases exponentially.” Vicki Callahan [1]

In the above quote from *Reclaiming the Archive*, Vicki Callahan is arguing that we move away from history as a strictly linear series of events, instead she posits that we look at history as a database of occurrences/moments that overlap, intersect, and speak to each other in unique ways. Her statement could as easily have been written about the confluence of abstract animation, music and generative art, as it was about history. This paper will explore multiple entry points in the history of abstract animation in order to highlight the historical underpinnings of selected attempts to visually represent music. By drawing attention to the work of experimental animators like Hans Richter, Oskar Fischinger, Mary Ellen Bute, and Vibeke Sorenson this paper will map the historical connections between music and animation as forms of generative arts practice.

Painting becomes one of the many entry points for talking about the history of abstract animation, music and generative art. Each of the animators I will discuss began their careers in painting and traditional arts practices. Lines of influence for animators Richter, Fischinger, Bute and Sorenson with avant-garde experiments in painting can be mapped directly through their involvement with these experiments themselves or indirectly through artistic training in art school. Early Twentieth Century experiments in painting by groups such as the Der Blaue Reiter (Blue Rider), Cubists, Futurists and Suprematists, often revolved around attempts to capture the dynamism of modern life: the light, color, form and movement of the urban experience on the canvas. Combining a fascination with spiritualism and symbolic uses of color, one of the founding members of Der Blaue Reiter group, Vassily Kandinsky, also strove later in his career to merge visual imagery, color and music. For Kandinsky "[the painter] naturally seeks to apply the methods of music to his own art. And from this results that modern desire for rhythm in painting, for mathematical, abstract construction, for repeated note, for setting colour in motion." [2]

The fruit of Kandinsky's application of musical methodology to painting can perhaps best be seem in works like *Composition VI* (1913) and *Yellow Accompaniment* (1924). The titles of the pieces alone, immediately call to mind musical arrangements and serve to reinforce the connection in Kandinsky's mind between painting and music. "Hearing tones and chords as he painted, Kandinsky theorized that (for example), yellow is the colour of middle C on a brassy trumpet; black is the colour of closure, and the end of things; and that combinations of colours produce vibrational frequencies, akin to chords played on a piano." [3] The synaesthesia with which Kandinsky purportedly painted also functions in the mind of the viewer. For example in *Composition VI*, one can hear chaotic musical accompaniment of this apocalyptic painting, the struggle between light (high notes) and darkness (low notes). The viewer sees the length of lines corresponding to length of notes; curving lines accounting for fluctuations in tempo; and the jumble of colors become the instruments competing with each other to be heard, the cacophony becomes overwhelming.

The desire to visually represent music and movement in painting coincided with the birth of cinema and this filmmaking naturally became a place where artists could explore visual music in a time-based medium. This new technology provided artists with a means of illustrating a more explicit desire to extend the boundaries of the art in terms of materials and/or techniques. Within filmmaking, animation, more specifically abstract animation became the place where artists could experiment with issues such as temporality, non-linearity, spirituality, dimensionality, visuality and of course musicality. These experiments range from the purely formal investigations of animators like Mary Ellen Bute (1906-1983) and Hans Richter (1888-1976) to quests "for expanded consciousness and spiritual fulfilment" with animators like Oskar Fischinger (1900-1967) [4] and Vibeke Sorenson (1954-present).

Mary Ellen Bute's experiments with animation arose, in part, out of an attempt to "find a method for controlling a source of light to produce images in rhythm." [5] It was during her work with musicologist-mathematician-painter Joseph Schillinger, Bute says she "learned to compose paintings using form, line and color, as counterparts to compositions in sound, but [she] felt keenly the limitations inherent in the plastic and graphic mediums and [became] determined to find a medium in which movement would be the primary design factor. Motion picture sound film seemed to be the answer and I began to make films, most of them abstract in content." [6] Of the 16 films that Bute created during her 20-year career, 14 of them are abstract experiments with light and sound. While little may be known of Bute now (outside academic circles), her films at the time were widely disseminated, often showing before feature films in theatres and many of them even premiering at Radio City Music Hall.

Her earliest animated works, like her 1939 film *Spook Sport* (made with the help of Canadian animator Norman McLaren) were made using traditional animation techniques – innumerable drawings done on paper and individually photographed. Bute's 1952 seven minute, hand-colored film *Abstronic* with Aaron Copland's "Hoe Down" and Don Gillis's "Ranch House Party," solidified her place in animation history as both a "America's foremost innovator of abstract animation . . . [and as] a pioneer in electronics imagery." [7] It was in this film that Bute was finally able to use light in dialogue with musical accompaniment.

Working with Dr. Potter from Bell Telephone Laboratories to adapt an oscilloscope for artistic rather scientific purposes, Bute, "By turning knobs and switches on a control board [she could] 'draw' with a beam of light with as much freedom as with a brush. As the figures and forms are produced by light on the oscilloscope screen, they are photographed on motion picture film. By careful conscious repetition and experiment, [she had] accumulated a 'repertoire' of forms. The creative possibilities are endless." [8] Bute's database of oscilloscope images, were both generated by her contemporary music choices and at the same time they generate an experience of the music that is unique. The flowing oscilloscope images provide an ethereal, fluidity to the animation, at times suggesting three-dimensionality. Not only are the creative possibilities endless, the possible responses that the various combinations of image and sound generate in the viewer are also endless.

German filmmaker Hans Richter also hoped to generate a unique and endless supply of viewer responses to his ground breaking 1921 film *Rhythm 21*. Prior to making *Rhythm 21*, Richter was peripheral member of Der Blaue Reiter and later participated in the Cubist and Dadaist movements in art. In Zurich he met Swiss artist Viking Eggeling and in 1918, Richter & Eggeling worked together to "systematically study the underlying principles of rhythm in painting … they completed a series of abstract drawings – variations on a theme – in which they created numerous permutations of basic compositional elements: time, shape, and so forth". [9] They took the most successful drawings and laid them out on a scroll, which could then be ‘read’ like a sentence or like hieroglyphs on an ancient Egyptian papyrus. The images could then be filmed using a single frame process and while Eggeling went on to utilize this format for his 1924 film *Symphonie Diagonale*, Richter quickly realized the limitations of this method, it’s inability to move past the painterly into the filmic. [10]

Rhythm 21, is not only one of the first abstract animations to be screened, it is also Richter’s first attempt at embracing the rhythmic potential/qualities of cinema. In the film, Richter utilized “the square (or rectangle) as the simplest way of dividing the square film-screen. The simple square gave me the opportunity to forget about the complicated matter of our drawings and to concentrate on the orchestration of movement and time.” [11] Shooting one frame at a time, the film itself was made by “manipulating cut-out paper squares under the camera and recording changes one frame at a time. During the duration of this film, which ran for a little more than a minute, these squares moved, expanded, contracted and changed tone in a carefully orchestrated kinetic composition.” [12]

It is through this planned arrangement of the squares and rectangles that Richter is able to create a sense of rhythm. This rhythm however is not based on any pre-established or recorded music, instead the flow of images across and around the screen is meant to generate a sense of rhythm/music in the minds of the viewers. Viewing the film takes on a meditative quality. Through the use of shape, size, shade and movement Richter creates a rhythmic database, or what animator Norman McLaren referred to as a canon. McLaren wrote, “In music the canon astonishes us. Just think! A single theme is used to accompany itself, two, three, or four times; it need only be staggered or overlapped in relation to itself, and, according to the method used, we get a network full of surprises!” [13] Richter builds this network from his rhythmic database, yet despite his careful orchestration, he requires the participation of the viewer who must make sense of and be mindful of the formal manipulations in order to generate their own rhythm.

Borrowing some of the formal aspects established by Richter, Oskar Fischinger’s *An Optical Poem* (1937) combines simple geometric shapes with movement and color to evoke the music of Franz Liszt’s *Second Hungarian Rhapsody*. Prior making *An Optical Poem*, Fischinger had an extensive career making abstract animation in Germany; inventing a special device which allowed him to create his experimental cut wax films, he played with stereoscopic imagery and there is “evidence that Fischinger produced several multi-projection film displays – an early for of installation art – at his studio around 1926 and also showed films as part of Farblichtmusik (Color, Light, Music), a multi-media presentation staged by composer Alexander Laszlo.”[14] Fischinger is also the most prolific of the animators I am speaking about, with over 50 animated films made during his 30-year career as a filmmaker. Perhaps more important than the bulk of his work, is the way in which through him, the history of abstract animation intersects with mainstream Hollywood filmmaking (the segment he worked on for Disney’s *Fantasia* and his time at Paramount and Metro-Goldwyn-Mayer).

One of Fischinger’s most well known films is *An Optical Poem*, the only film he made for MGM. Like Richter, Fischinger uses cut-outs, his however are mounted on clear wire and he moves them on multiple planes in front of the camera, allowing him to create a sense of dimension, at varying speeds/tempos to accompany the music by Liszt. Film historian, William Moritz describes how the shapes move in *An Optical Poem* – the squares, rectangles, triangles, and circles "move in irregular clusters like traffic in a market place, they march, they dance, they fly, they orbit each other in twos and threes and fours, they melt into each other, they recoil suddenly away from each other, they expand and contract rhythmically and flicker, alone, together, and across stunning multi-plane perspectives. The 'meaning' is for each viewer to contemplate: *An Optical Poem* is an instrument for meditation – microscopic, universal, personal." [15]

The meditative quality generated by *An Optical Poem* is established not only through the careful utilization of Fischinger's of shapes, movements and editing rhythms, but also through his use of color. Shot in glorious Technicolor, the film is a study in synaesthetic sound. Fischinger takes full advantage of the richness of the Technicolor stock to accentuate the connection between shape, color (red, blue, yellow, green and their myriad variations), movement and sound. The strength of the connection to synaesthesia is that the film functions as a beautiful piece of meditative filmmaking just as well without the sound as with.

The contemporary work of Vibeke Sorenson builds on the formalism of Richter, the fluidity of Bute and the meditative qualities of Fischinger. In a sense, each of these early filmmakers becomes one of the multiple entry points that speak to and are spoken to by the digitally generated work of Vibeke Sorenson. As an architecture student in 1971 Sorenson started contemplating the possibilities of computer generated imagery and electronic sound as a form of artistic expression. According to Sorenson, she "envisaged [much like Mary Ellen Bute] an advanced light-based art form, a kind of three-dimensional painting that would come off the canvas, surround [her], and move in response to [her] commands, similar to the way a musician uses an instrument to control and shape the parameter of sound." [16] In an effort to achieve that goal, Sorenson has worked with scientists to develop new technologies, among them an interactive stereoscopic animation system conceived at the San Diego Supercomputer Center.

Sorenson's 1991 stereoscopic film *Maya,* with stereo music by Rand Steiger and Tim Labor, utilizes the new technology developed at SDSC and allows her light-based imagery to literally jump off the canvas/screen with the illusion of three-dimensionality. According to Sorenson, with *Maya* (Hindu for illusion, it also implies the liminal space between illusion and reality) "in terms of visual and spatio-temporal form, [her] intention was to use sustained permutations of light, color and shape to create an experience that is reflective of life and the natural cycles that repeat continuously." [18] She goes on to note that the film "on one level pays homage to the continuing tradition of abstract art and to the liberating effect of new and developing technology. On another level it's a personal meditation, an introspective work that focuses on [her] own inner rhythms and spirit." [17] The homage that Sorenson speaks about can be seen, not only in her use of geometric shapes that call to mind films by Richter, Eggeling and Fischinger, the fluid movement of the light shapes across the screen calls to mind the electronic/digitally generated images of Bute, John Whitney and Len Lye.

Like Kandinsky and Fischinger, Sorenson's use of color has synaesthetic qualities; the fluctuations between rich hues, especially the reds and blues of *An Optical Poem*, shades of pastels and hints of the metallic all call to mind sounds and tones generated by the electronic instruments. The synaesthesia also speaks to the second level Sorenson discusses in relation to *Maya*, that of personal meditation, both her own and the viewer's as well. The ethereal music composed for the film generates and accentuates the meditative process, drawing the viewer in as the images float, soar and mutate across the screen.

This film, like the other films discussed encourages and even requires an active spectator to participate in making sense of the combinations of color, image, movement and sound. According to animation scholar Maureen Furniss, abstract animation serves "as an 'open text', which leads beyond the film itself . . . challenge[s] the viewer to participate in the process of creating meaning." [19] In this sense, Sorenson's film *Maya*, becomes one of the multiple entry points into history posited by Callahan at the beginning of this paper. The film is both a database of sound/image and through it's intertextuality it is also a database of the intersections, overlappings and duplications of film history. I would also argue that it is this open-endedness, which connects abstract animation with generative art practices.

I would like to close with Vibeke Sorenson's thoughts regarding the future of computer stereoscopy and interactive media systems, Sorenson notes, "This kind of electronic connectivity could lead to the dissolution of the traditional art triad with the artist, the object, and the audience forming a new type of relationship that emphasizes interactive participation. Object making, in this sense would be totally virtual. Forms and figures would be capable of moving within a mutable and multidimensional environment without physical limitations or the constraints of linear time. In this context, on-line forms of stereoscopic imaging would be constructed from multiple and diverse sources, generating a dynamic feedback process that would potentially allow us to see others and ourselves during the act of creation." [20] For Sorenson, the future of abstract animation mirrors speaks to Callahan's view of cinematic history, as becoming innovative, interactive and democratic.

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Mag. Oliver Gingrich, MA Fine Art

Generative Art - Interactive Art: Delineations, Crossovers and Differences

Topic: Interactive Arts – Generative Arts

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In digital art theory, the histories of generative art and interactive art are considered fundamentally interrelated yet distinctively defined - mutually dependent, yet clearly distinguishable by their respective discourse domineering definitions. In the practise of digital art, a multitude of hybrid art forms challenge both definitions and allow for questions on the nature of both artistic currents. Both concepts share a long tradition in the arts, yet both concepts have been refined continuously by scholars and academics over the last decades.

Their discussion has recently gained further momentum as both art forms received heightened attention in artistic institutional discourse, curatorial display and theoretic reception over the last decade. This paper focuses on the two neighbouring fields in the digital arts, their respective traditions, their demarcation lines and theoretic concepts as well as hybrid cross-overs of these art forms that challenge their current definitions.

Analema Group: Eugenia Emets et al. Kinetica 2012 London 2012

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Generative Art - Interactive Art: Delineations, Hybrid Media and Conceptual Differences

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Abstract

In digital art theory, the histories of generative art and interactive art are considered fundamentally interrelated, yet distinctively defined - mutually dependent, yet clearly separated by their respective discourse shaping definitions. Equally, in art practise, a multitude of hybrid art forms challenge these definitions - allowing for questions on the nature of the two currents. Both genres share a longstanding tradition in the practise of digital arts, while their theoretic concepts have been constantly refined by scholars over the last decades. Recently, their discussion has gained further momentum as both art forms received heightened attention in institutional discourse, curatorial display and theoretic reception. This paper focuses on the two neighbouring fields in the digital arts, their respective traditions, their conceptual demarcation lines and theoretic implications. We are singling out examples of hybrid nature, conceptual cross-overs between interactive art and generative art - that challenge their respective domineering definitions.

Interactive Art – between conceptual approach and technical innovation

The Oxford Dictionary defines interactive as allowing a two-way flow of information between a computer and a computer-user, i.e. as responding to a user's input. A computer is defined not only as an electronic device, but secondly as a person who performs calculations, especially with a calculating machine. It is this second definition of computing that we need to engage, if we are looking for an expanded definition of interactive art that includes art production before the 1960s. In the strict sense of the term, interactive art is linked to the history of computers as an electronic device which is capable of receiving information (data) in a particular form and of performing a sequence of operations in accordance with a set of procedural instructions (program) to produce a result in the form of information or signals (Oxford Dictionary).

Although the word art and technology derive from the same epistemological Greek roots – the word techne- interactive art does not primarily focus on technical explorations alone. In interactive arts, technology exists only as a tool to explore new realities, new forms of engagement and new expressions of meaning. Wong, Jung and Yoon from Seoul's Soongsil University argue that it is not sufficient for the work to react based on the spectator's selection, but interactivity should allow the meaning behind the interaction to be discovered (Wong, Jung, Yoon 2009, p.180). As Maria Teresa Cruz declared - "Interactivity is not a specifically technological issue (Cruz 2009, p.2)."

The artist Nathaniel Stern states that in interactive art "installations are not objects to be *perceived* but relations to be *performed*" (Stern 2011, p. 233) Interactive art is often understood as a subgenre of installation art – yet performative actions, live audience participation and real time engagement are its integral components. Interactive art has its roots in performance arts, happenings and the explorations of Fluxus. In between sculpture and installation, performance and participation, technology and tradition – interactive art is considered platform independent and hybrid per se – bridging many conceptual rifts.

Edmonds and Mueller assert that interactive art privileges experience over static objects (Edmonds, Bilda & Muller 2006, p.142)." As conceptual credo, this observation echoes Nicholas Bourriaud's political account in *Relational Aesthetics* "that art is at once the object and subject of an ethic - art is a state of encounter" (Bourriaud 2001, p.18). While Bourriaud's umbrella term centres around social contexts and the discussion of social engagement, interactive art is a social dialogue in itself – a social encounter per se. According to Veronika Korakidou and Dimitris Charitos, in interactive art, *"the visitor is the one that completes the artwork. Without him/her, the artwork does not exist*[i] *(Korakidou & Charitos 2011, p.281)."*

Geoffrey Keays at the MIT points out that interactive art is as old as the cave paintings of Lascaux, which date back to 13000BC. Ipso facto, the history of interactive art is not merely a history of technical advances (Keays 1999). The history of interactive art encompasses a history of audience participation, physical engagement and participatory authorship. As such interactive art doesn't always entail high tech gadgetry or the use of ground-breaking technology. Marcel Duchamps Bicycle Wheel (1951) - transformed a bike wheel into a kinetic art piece. When audience members' physical interaction created a readymade out of a single wheel, they also altered its visual effect on other audience members.

The way we experience interactivity in the arts changed dramatically throughout art history. Technical advances and innovation influence the way artists tackle inseminations of interactivity in the artistic practise. In “Interaction, Participation, Networking - Art and Telecommunication”, Peter Weibel explores the terms interactivity/interaction in the context of art history. Definitions of the term appear vague and fuzzy if studied over time - as concept and practises of interactivity underwent multiple transformations across the decades. From Nam June Paik or Robert Rauschenberg’s Fluxus pieces of the 50s, to Gene Youngblood’s immersive Expanded Cinema experiments of the 60s, to Dan Graham, Valie Export or Peter Campus’ video pieces and closed circuit installations of the 70s, to Christa Sommerer and Laurent Mignonneau, Jeffrey Shaw or Lynn Hershmann’s pieces of the 1980s and 1990s to to current interactive art practises –spectators’ roles shifted with technical possibilities and altered conceptions of mediation. Interactive art is art that engages the user in a two way flow of information so that the artwork is significantly altered through his or her actions. The artwork wouldn’t exist without the spectators’ input.

As Christiane Paul (2004) concluded, interactive art is not a recent phenomenon in art production – as all art inherently strives to be interactive. Credited as one of the first major exhibitions worldwide to feature computerised interactive art – Jasia Reichhardt’s seminal “Cybernetic Serendipity” at the Institute of Contemporary Art set the tone for its academic discussion: Out of the 143 contributors, 43 were composers and 87 were non-artists: engineers, doctors, scientists and technologists. Interactive art is deeply rooted, but not restricted to a wider discourse on art and technology.

The ICA – Institute of Contemporary Arts London - also set a second milestone in the contemporary history of interactive arts: In 2008 the late artistic director Ekow Eshun decided to close the institution’s Live and Media Department – a locus operandi hitherto dedicated to performative and interactive art alike. Eshun and the ICA reasoned that it was impossible to artificially segregate these art forms from others any longer – interactive art is everywhere.

Between technology, installation and performance, artist happening and audience participation – the very essence of interactive art is to evade genres and classifications. Generative Art – an art that is closely associated with discourses on artificial intelligence, cellular automata and technical autonomy is a neighbouring discipline of equally blurry conceptual boundaries. Dedicated museum spaces such as the ZKM in Germany, FACT Liverpool in the UK, Gaité Lyrique in France, or the ArsElectronicaCenter in Austria- committed to the field of art and technology, digital art and interactive art – are focusing on both debates – side by side, yet within clearly demarcated theoretical discourses.

Generative Art – art as computational process and autonomous system

In What is "Generative Art" Philip Galanter defines his conception of Generative Art as "*any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art.*[ii] *(Galanter 2003, p. 4)"*

This broad and open definition reflects an inclusive approach, restricting the field within the digital arts on the use of autonomous systems in the process of its artistic production. Generative art is a rule based art form, closely linked to the fields of complexity theory and artificial intelligence. Outside the context of art theory, various definitions of autonomy exist: The Oxford dictionary, ties the concept to a philosophical or political background - by linking the term to the notion of freedom of choice. Autonomy is either understood politically as *"**the freedom for a country, a region or an organization to govern itself independently**"* **or in a philosophical context as "*the ability to act and make decisions without being controlled by anyone else giving individuals greater autonomy in their own lives."* None of these definitions have had any repercussions in the discussion of generative arts. Prevailing definitions centre around a terminology borrowed from artificial intelligence (see: Galanter 2003, McCormack 2001 and Edmonds 2009).**

In artificial intelligence and robotics, the term "autonomy" has played a crucial role to refine both control and intelligence. From the outset, artificial intelligence served as a conceptual backdrop for generative arts - whether on a theoretical level or in computational practise[iii]. The European Space Agency's definition of autonomy in is strictly constrained to a set of conditions to be met by a robotic system. Both the term autonomy itself and definitions for its subsidiary "degrees of autonomy" are thus technically restrictive and exclusive: Only when all of the six conditions are met *and "performed without human guidance" a robot can be called Autonomous*[iv]*.* This definition clearly earmarks autonomy as a concept defined through the *exclusion of human interaction*. Autonomy is understood as self-reliance of a learning system. Its self-subsistence and self-sustainability for growth, intelligence and corollary progress-based results explicitly excludes human interference.

In "Autonomous Robots: From Biological Inspiration to Implementation and Control" George Bekey refers to autonomy as "a system being capable of operating in the real world environment without any external control for extended period of time"[v]. The very definition of autonomy in AI and Robotics is based on the idea of circumvention of external control i.e. human intervention. On the contrary, definitions of interactive art tend to focus entirely on human intervention, concentrate on active human participation in the creation of a "completed work of art".

Similarities in both art forms include proximity to technological discourses, frequent use of computational practises, and a rule based approach that centres often on questions of chaos and control. Both traditions have a long history, with a recent resurgence in artistic production and institutional prominence. Both traditions are now firmly linked, but not exclusively confined to contemporary digital art production. Furthermore, both terminologies and their conceptions have frequently changed over the last decades.

Similar to the history of interactive arts, the history of generative art is as old as mankind and not intrinsically linked to a discourse on technology. Philip Galanter points towards Christopher Henshilwood's discoveries of cave paintings of triangular shapes – 70,000 of age (Galanter 2003). Iterative symmetry and geometry have been integral part of artistic creation from the Assyrian civilization to contemporary art production today. Yet it isn't the inherent symmetry that makes these ancient art forms a subset of generative art. Generative art is neither considered to represent a style, nor a technique. According to Galanter, "in principle, any computer based generative method could be carried out by hand.(Galanter 2003, p. 16)" Even though the terms -computer art and generative art- were used interchangeably at their introduction into academic discourse in the 1960s, computers do not necessarily constitute for a term defining variable.

Henry's Drawing Machine is considered to be more of a machine than a computer. In 1962, this generative art tool earned Desmond Paul Henry the title of being the first generative artist to exhibit in a solo show. Equally, John Whitney's converted M-5 "Anti-Aircraft" had little resemblance with a personal computer, yet this apparatus and its results are widely recognised as early examples of generative art in their production of slit scan images. As discussed, neither style nor techniques are per se defining factors for generative art. By definition, their main constituents are defined by the prevalence of a rule based system for the creation of autonomous artistic processes.

Early computer art was often perceived as congruent, if not equal to generative art: Georg Nees and Frieder Naacke are widely recognised as pioneers of computer art and generative art alike. Georg Nees and Frieder Nake's seminal exhibition "Generative Computergraphik" in Stuttgart 1965 is widely recognised as being the first of its kind – four years prior to Cybernetic Serendipity. Both artists used the term "generative" to describe artwork that was at least in parts automated and ultimately produced by a computer (Boden & Edmonds 2009, p. 23). Stephen Wilson or Ed Manning used computer plotted lines to create generative art. Other generative artists, such as Nicholas Schoeffer, Joseph Nechvatal or composers such as Cage used completely different means and techniques to the same end – to produce rule based art that is the result of automated procedures.

With the advent of software art, and the explosions of personal computers in homes of nuclear families worldwide, the terms computer art and generative art experienced both - a certain degree of dissolution and a clearer delineation in its discussion. A series of conferences and a wealth of publications led to a refined distinction between the terms. Philip Galanter's relatively young definition is preceded by decades of artistic production in generative arts that saw revolutions in music (John Cage, Lejaren Hiller), installation art (Brian Eno, Sol LeWitt) and program based art (Jon McCormack, Mark Napier). More recently generative art proponents transgress borders of any subgenre (Marius Watz, Genetic Moo, Michael Takeo Magruder from King's Visualisation Lab).

The theoretic framework of generative art is deeply rooted in artificial intelligence and cybernetics - both in practise (Roy Ascott, Gordon Pask) and theory[vi]. In robotics and artificial intelligence, the term "autonomy" conscribes a set of technical conditions for a given robotic system: Capable of interpretation of directives, such a system needs to be environment aware, self-controlling and able to anticipate outcomes of its own actions (see: European Space Agency ESA[vii]). In generative art, autonomy as a concept takes its terminological references and linguistic clues directly from Artificial Intelligence.

Algorithms and rule sets are a fertile ground for generative art – art that operates in a system of self-subsistence no matter whether this is language (Sol LeWit), physics – (Hans Haacke – Condensation Cube, 1965), biological paintings (Joseph Nechvatal) or architecture (Celestino Soddu). Generative Art is subject to controllable directives, capable of self-control and predictable as it relies on a set of rules for its creation. Artistic creation often starts with a conscious choice of these rules, but isn't limited to any medium, topic, technique or philosophical context. Questions of order and chaos are intrinsically linked to these rules and determine its philosophical proximity to complexity theory (Stephen Wolfram and others).

Generative art is either outcome or process of an artistic production based on autonomous systems - thus excluding human spectator agency. Interactive art, on the contrary, is based on spectatorship agency. Interactive art is per definition either the process or creative result of inter-subjective human art generation. At first, demarcation lines of both art forms seem very clearly defined. At the heart of creation and discussion of both art forms lies the same question on chaos and control: In interactive art and in generative art, controllability is reached through rules: In generative art rules create art, in interactive art the absence of rules defines human interaction. Yet the very artists whose work leads to a discussion of these terms, continuously raise questions on authorship and visitor participation throughout their work – thereby challenging the concepts of their own genres.

Analema Group – Khaos – performed at Kinetica, London 2012

Generative Art or Interactive Art?

In both generative art and interactive art, a broad academic consensus has accepted dominating definitions for both art forms – defintions that seem related due to their inclusiveness of computer agency, yet appear mutually exclusive in the role they attribute to human intervention. Artistic practise has always challenged academic debates, a critical role further pursued in the digital arts. The practises of both generative art and interactive art deviate from their respective theoretical context – challenging our conception of computer-human interrelations. To the extend that we question where an autonomous computerised process starts and where it ends, where the radius of action for humans follows automated procedures, where we find distinctions between humans and cyborgs (Donna Harraway 1990), human and posthuman (N. Katherine Hayles 1999), or if the new philosophies for new media (Mark B. Hansen 2004) are so new after all. By challenging existing definitions of digital art, artistic practise engage in theoretic meta-discourses on broader subjects on the relationship between humans and computers.

Exhibitions such as “Talk to Me” (MOMA 2011), Decode (V&A 2010-2011) or “Choreograph Me” (2010-2011) at the Hayward Gallery – focus on the the role of the audience in the exploration of contemporary interactive art production. All three exhibitions milestone in the curatorial discussion of their respective fields, present pieces that can be classified as either “Generative Art” or “Interactive Art”, yet none of these shows draw a distinctive line between the two concepts. Current definitions for both digital art categories point to clear-cut concepts that are mutually exclusive, conceptual antagonisms, ergo ask for distinctive denotations for both art forms. yet these elemental definitions do not seem to resonate in either practise of art production or the realities of their presentation.

In Nicolas Myers piece “Transgenic Bestiaries” – exhibited at “Talk to Me” spectators create autonomous organisms of new species out of an existing DNA stock. Mixing and matching, the spectator becomes the creator of a new life form - an artificial intelligence created out of DNA code – is this generative art or interactive art? Modified DNA code create autonomous systems, life forms that are self-sustainable and non-dependent on human interaction, yet these forms need human interaction to be initiated. Generative Art or Interactive Art – what are we looking at?

In one of the now classic pieces of interactive art, “interactive plant growing” by Laurent Mignonneau and Christa Sommerer(1993), plants act as an audience interface to control the real time growth of artificial, generative, virtual plants. Plants become an interface for real-time controlled generative art, art that is both generative and interactive – autonomous as a biomechanism, yet dependent on human interaction to become visible, to become alive.

Botanicus Interacticus, presented at Siggraph 2012 echoes Sommerer and Mignonneau’s seminal piece: Digital organisms are created through real life forms, human interaction triggers generative computer art as a mirror image of biodiversity, and biomechanics. Developed by Ivan Poupyrev from Disney Research, Pittsburgh and Philipp Schoessler, University of Arts Berlin, their “interactive plant technology” displays plants acting as a transmitter of electrical currents, currents that are then transformed into real-time generated digital organisms – visible only in a mirrored reflection behind their emitter. The visitor triggers digital growth of these generative digital art forms through his interaction with the live plant. Should we classify this as an interactive form of generative art or a generative display of interactive art?

At Kinetica 2012, London’s biggest annual event for art and technology, the artist Eugenia Emets presented Analema Group’s Khaos. Analema Group is a collaboration between Eugenia Emets (artist), Mohammad Taha (3D animation / design), Eurico Moita (programmer), Patricia Afari (sound artist / programmer) and challenges the very definitions of generative art and interactive art: Using a large scale “Pepper’s Ghost” interface – the Musion screen, Eugenia Emets interacts with a generative algorithm, her live motion performance controls fractal shapes. Generative art in its purest form - 3d fractals – are created through algorithmic code, interactively controlled and modified through movement in space and live sound. The human becomes a cyborg, a live form of digital code in an interactive performance of an intrinsically autonomous; code based art generation: A form of generative art or of interactive art?

In our own research at the CDE – Centre for Digital Entertainment – a joint institutional postgraduate centre by Bath and Bournemouth University, Alain Renaud, Oliver Gingrich and the artist Eugenia Emets, work on artistic strategies to translate principles of cymatics – the transformation of matter through sound waves- into code based digital art work. Code representing interference patterns of liquids generated by sound is visualised using a a large scale Peppers Ghost display – the Musion screen. Users experience their own actions as physically tangible sound, communication as the emergence of interference patterns of two interrelated soundscapes. The result consists in the 3D visualisation of cymatic principles – a generative art form that is constantly modified by interactions between people. Here, a code based, autonomous system is acting as mediator between people, rather than mere representation of a self-contained system. Yet, to paraphrase Marshall McLuhan, the medium is the message: At the base of any generative art, however autonomous the result, lies human input as a decision making process by the artist. Autonomy of any generative computing system is only ever possible through initial human input. In this case, users become artists, as the audio-visual system it is only ever generated if the input equals human interaction.

Current artistic production challenges the very notions of the theoretical context it operates in – evading all classifications, categorisations and definitions. Digital art is prompting us to ask broader questions, not only on the nature of generative and interactive art, but on artificial intelligence and human performance – on chaos and control and on the complex and intertwined relation between computer and human.

This paper presents generative art and interactive art as two distinctive concepts with their own traditions, theoretic backgrounds and academically recognised definitions. Both art forms are presented as diametrically opposite concepts, concepts at once distinctive, concurrent and yet often interrelated. Contemporary digital art practise shows us that the relationship between computer and human, spectator and author, quasi autonomous systems and visitor engagement are more complex than their dominating definitions seem to establish:

A multitude of hybrid art forms exists – transgressing the confinements of both conceptual schools of thought. Over the last decades, the role of the spectator in art production and art consumption has shifted towards a more integral and pro-active one, while the role of technology and computers in artistic art production changed from secondary to omnipresent. In contemporary artistic institutions, human actions and interactions are computer penetrated or computer aided wherever we look; To the extend that computers are forming part of communication processes, generative art, hitherto a biotope of autonomous computer generated art production is being conquered by human interactivity. We are experiencing a multitude of art forms commenting on hybrid forms of communication, a multitude of art forms that challenge both: the concepts of autonomy of computers, and the autonomy of being human.

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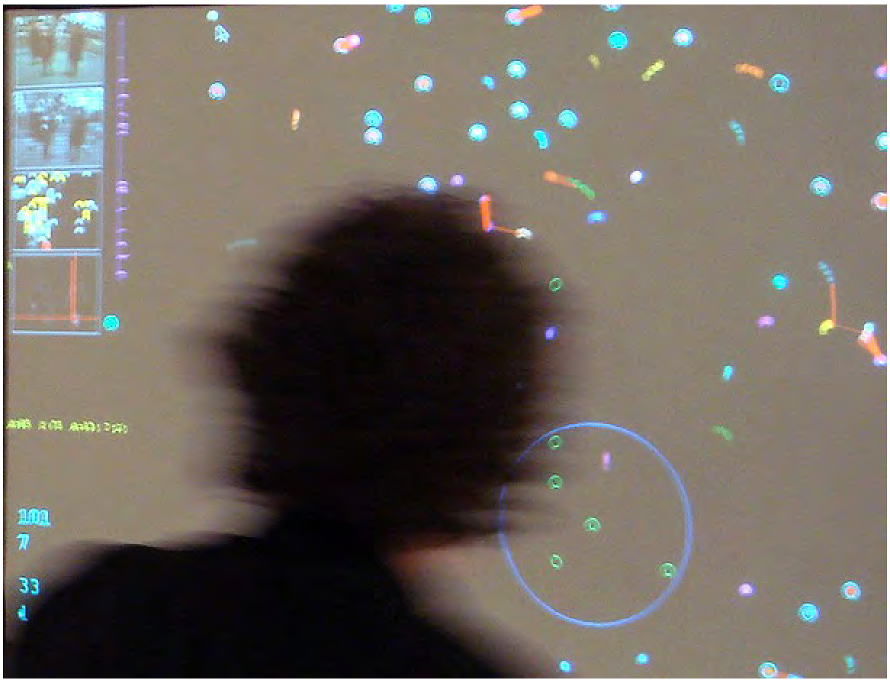
Peter Beyls

Paper

AUTONOMY, INFLUENCE AND EMERGENCE IN AN AUDIOVISUAL ECOSYSTEM

Abstract:

This paper provides a concise introduction to *Petri*, an interactive audio-visual installation built as a society of communicating virtual agents developing autonomous behaviour but equally sensitive to outside human-originated influence. From a systems point of view, this work consists as a dynamic interface connecting life in an artificial society with life in a given tangible physical environment. Design principles include the synthesis of sustained forms of emergent audio-visual/behavioural complexity over time, short-term complexity from simple local interactions and long-term complexity made available through genetic optimisation. Petri suggests that partial understanding of systems behaviour blended with the accommodation of surprise makes for a rewarding aesthetic experience.



Petri, an interactive audio-visual installation.

Topic: Visual art

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Autonomy, Influence and Emergence in an Audio-visual Ecosystem

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Abstract

This paper provides an informal introduction to Petri, an interactive audio-visual installation built as a society of communicating virtual agents developing autonomous behaviour but equally sensitive to outside human-originated influence. From a systems point of view, this work consists as a dynamic interface connecting life in an artificial society with life in a given tangible physical environment. Design principles include the synthesis of sustained forms of emergent audio-visual/behavioural complexity over time, short-term complexity from simple local interactions and long-term complexity made available through genetic optimisation. Petri suggests that partial understanding of systems behaviour blended with the accommodation of surprise makes for a rewarding aesthetic experience.

1. Introduction

An early morning walk in a forest is a rewarding experience to most of us; one participates in a completely autonomous audio-visual universe acting as a self-sustaining biotope. The quality of the experience is modulated by a delicate blend of recognition and surprise; one becomes an unobtrusive kind of “discreet participant” in an autonomously unfolding (natural) world. The theory of anticipation (Huron 2006) applies – the intensity of the individual experience is highly conditioned by a dynamic process, i.e. the continuous cognitive evaluation of the relationship between expectation and surprise. In fact, the forest metaphor promotes constructive principles for designing artificial ecosystems: (1) a continuous scale from microscopic to macroscopic emergent complexity seems basic to natural environments, and (2) natural ecosystems are responsive to perturbations and gracefully accommodate disturbance by external forces such as human beings, natural artefacts remain flexible in terms of behaviour and metabolism.

Petri characterises human-machine interaction as a process of mutual influence. The outside world as considered an “environment”, a physical world where, typically, multiple people exercise spontaneous body language as well as engage in natural social interaction. *Petri* explores the aesthetics of interaction by way of direct implementation of a virtual world developing autonomous activity, however also open to external influence. *Petri* is conceived as a large-scale audio-visual installation; a projection made available as a dynamic interface to be appreciated by humans. As depicted in figure 1, we think of two co-existing environments being interfaced; (1) a synthetic universe formalised in computer algorithms and (2) a physical (public) real-world space. Many parallel trails of activity in both worlds coalesce as macroscopic human-centred aesthetic experience. This approach contrasts with call-and-response systems where user actions trigger a selection from a fixed palette of responsive options.

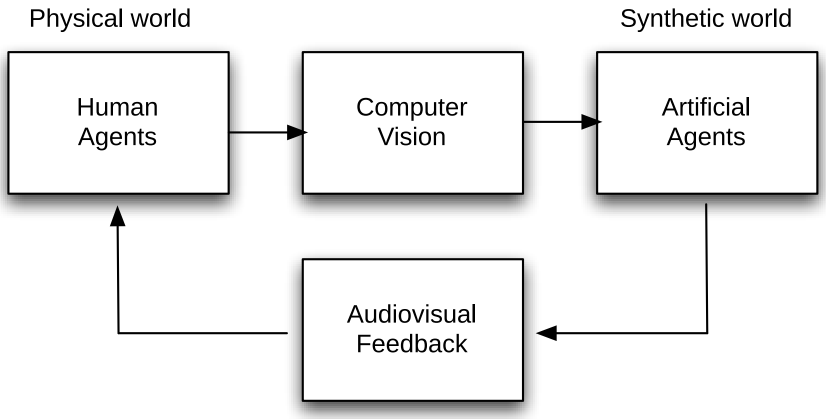

Fig.1. Global systems organisation.

Meaning is created explicitly by a clear sense of correlation between action and response. *Petri* views interaction as cognitive interactivity: the psychological, emotional and intellectual *participation* between a person/a crowd and a system. *Petri* implies implicit interaction in the sense that the system is (1) considered a micro-world of interacting components in itself and (2) a global system behaving in relation to human influence. By definition, such systems abandon the notions of authority and control in favour of a distributed systems architecture supporting life in shared biotope.

Also, the work reported here explores the concept of a reciprocal system where user behaviour exerts influence over an otherwise completely autonomous system. The net result is complex emergent behaviour in the agency merging seamlessly with spontaneous human bodily behaviour. This study suggests that rewarding human-machine interaction is sustained by a delicate interplay of prediction and surprise while appreciating complex emergent systems behaviour. Petri is a typical example of emergence because simple, local interactions between system components (called “particles”) give rise to complex emergent global systems behaviour.

Another design principle is the quest for “diversity”. In a television interview on Dutch TV, while referring to the massive variations in size and shape of shells of land snails Harvard palaeontologist Stephen Jay Gould defined beauty as an enjoyment of evolution-based variations and change; “For this is beauty for evolutionary biologists because we love diversity”. The notion of emergence teaming up with a simple genetic algorithm provides for the maximization of diversity in Petri. As noted by Dorin (2005), diversity in biological organisms is one trait that recommends the ecosystem artistic composition; ecosystems guarantee the autonomous production of novelty. Evolutionary pressure instructs organisms to develop novel structures and behaviours to improve reproductive ability.

Rewarding human-machine interaction is viewed as an interface between two universes, both holding agents engaged in social interaction. Humans interact according to salient social rules, while particles interact in a synthetic universe managed by invented rules. Both universes exhibit self-organising complexity and their confrontation reveals a particularly rich platform in support of spontaneous aesthetic human-machine interaction.

2. Related work

Some early work in agent-based interactive environments involved animated avatars claiming the suspension of disbelief as a key ingredient of rewarding human-machine interaction; the *ALIVE* project is highly exemplary (Maes 1997). Other work necessitates an immersive relationship with the human participant fully engaging the senses; the *Emergence Engine* (Mendelowitz 2000) supports interaction through voice, hearing and touch. Obviously, the suspension of disbelief requires the implementation of reasonably realistic real-world physics. In addition, the works present themselves as a visualisation of a kind of artificial landscape inhabited by virtual creatures. The project introduced in this paper avoids real-world connotations in favour of total synthetic authenticity.

Various interactive music systems are take inspiration of Reynolds' flocking model (1987), including *Swarm* (Blackwell 2004). A mapping function specifies a link between the spatial position of agents and features of the environment – it thus implements the general statement of stigmergy. For instance, an external sound may function as a temporary attractor while the flocking rules still force self-organised behaviour.

Two excellent examples of audiovisual ecosystems are *Eden* (McCormack 2001) and *Diseases Squared* (Dorin 2005). Eden is a reactive cellular virtual world, driven by a genetic algorithm using an implicit fitness function – systems behaviour acknowledged by participants moving in space receive higher fitness ranking. *Eden* evolves according to audiovisual cues from an audience and its implementation takes heavy inspiration of John Holland's *Echo* system.

Diseases Squared is conceived as a virtual machine for artistic pattern creation supporting multi-scaled temporal complexity, autonomous production of novelty, susceptibility to constraints and maintenance of coherence and unity. Bio-diversity is seen as way to enhance novelty without however destroying coherence. This implies that the system must function within a range of possibilities, holding a balance between sufficient novelty and sufficient coherence. The extremes of novelty and coherence are related to respectively high mutation rates and convergence in the context of evolutionary algorithms. In addition, in the context of artistic creation, the extremes are viewed as randomness and uniformity. Dorin makes a connection by suggesting that the implicit fitness function, which aims to maximise reproductive success in a biological ecosystem, may work as a method to navigate between novelty and coherence.

This project takes additional inspiration from distributed thinking in the fields of cognitive science (Minsky 1985), the flocking model devised by Reynolds (1987) and the discipline of artificial chemistry. In addition, *Petri* takes its name from the shallow *Petri* cell culture dish commonly used in the field of microbiology and builds on previous research viewing human-machine interaction as interfering with colliding molecules (Beyls 2005).

3. System description

Petri's universe consists of a collection of animated particles moving about in a virtual world while also interfaced to the real world by way of computer vision. The implementation is fully object-oriented, let us first address the nature of the Particle Class.

A particle moves in 2D space (with bouncing walls) and is sensitive to neighbouring particles as well as human interactors. In addition, particles consume energy and occasionally enter a sleep cycle for some time and wake up with full energy later on. Velocity and angle of movement are important additional instance variables. The gender variable plays a significant role in the reproduction process and holds four different values; a lookup table specifies specific options for particles to breed.
All particles hold a data structure to control a FM software synthesiser defined and instantiated in SuperCollider (Wilson et al. 2011).

Particle display is conditioned by the current values of various instance variables such as status (awake or asleep), sensitivity and the number of neighbours.
Sensitivity to human activity is an adaptive feature; when within the zone of influence of an external interactor (or possibly a group of people) sensitivity is scaled up else it is scaled down. At specific moments in time, visualisation is further conditioned – for instance, when a nascent particle is about to be bred in Petri's world.

When outside the zone of influence, a particle engages in a process of competition with one of its neighbours if that potential neighbour itself is outside the zone of influence and it has at least one neighbour. A particle will delete all its neighbours that are of a different gender and are currently in sleep state.

A particle continuously interacts when awake (status = 1); when the distance to any other particle is within range of the sensitivity parameter, it increments its angle of movement and slightly lowers it velocity.

A given particle will influence the behaviour of any neighbouring particle when (1) it is currently awake, and (2) the distance to a potential neighbour is lower than its neighbour-sensitivity instance variable. A particles slows down when interaction and when its velocity is lower than a given threshold, it enters a sleep state (status = 0) for a given number of process cycles. When waking up later on, maximum velocity is restored and signalled by a local blink in the graphics display.

The World-class object in Petri holds a variable collection of particles (between 50 and 250) and many critical system variables. The world cycles through a number of top-level procedures handling (1) inter-agent interactions, (2) computer vision, (3) accommodation of user interaction, (4) the particle breeding and elimination process and (5) sound handling via OSC to Supercollider.

Computer Vision (CV) procedures intend to connect the internal, virtual world of Petri with the dynamics of a specific ‘external’ world, typically a public space setting. As a sensing technology, CV offers the advantages of being non-obtrusive; it provides detailed spatial information and may be implement with great efficiency. CV is a five-stage algorithm in this project. First, a frame is captured (50 times per second) and a low-resolution (180 by 120 pixels) version is computed. Second, the difference between the contents of the last frame and the previous frame is calculated in terms of the absolute value of the changes in brightness of every pixel. Next, an image buffer is updated according to the data made available at stage two; it acquires changes in a dynamic memory structure. For every image/memory location, the data is boosted when significant changes occur while it is slightly scaled down otherwise. The net effect is that of a very much responsive yet slowly fading “image memory”. Fourth, the “direction of change” in the image is computed from the comparison of the locations of the brightest pixels in the current frame and the previous frame. Fifth, at any point in time, the locations of the maximally changing pixels are considered “centroids of change”, they are captured in a dynamic list and visualised as a kind of trail signalling changes in the external, physical environment.

The next software module acknowledges the information made available by CV; it will condition the particle behaviour in specific ways. Particles are attracted by changes in the physical world and tend to move towards the location where these changes actually take place. In addition, a centroidLevel variable is scaled up or down in proportion to the total amount of change between consecutive CV frames; in absence of changes the level gradually moves towards zero.

Changes in the physical environment exercise global (the virtual world as a whole) and local (at specific locations) impact; for instance, particles may reposition themselves if the centroidLevel is peaking at its maximum (i.e. a normalized value of 100%). Also, the higher the centroidLevel, the stronger the particle attraction of moving toward a target defined by the centroidPosition; the current XY-location of maximum change in the CV image buffer. Typically, the CV module senses a dynamic environment, external activity leaves a variable trail in terms of target dynamics and target location – therefore, local particle behaviour is influenced in especially subtle ways in addition to the fact that the history of changes introduces complex non-linear global systems behaviour.

The next software module handles the reproduction process. New particles are instantiated in proportion to the number of particles within the zone of human influence. A new particle will be born out of the genetic make-up of two randomly selected particles within the zone of influence. The newly bred particle appears physically close to one of its parent particles, its gender is decided from the consultation of the current reproductionTable. The contents of this table is subject to continuous evaluation: it contents is filled with random numbers when either the total number of particles drops too low or there is too much convergence towards a world holding particles of a uniform gender. This higher-level adaptive mechanism guarantees global survival of the world yet offering persistent genetic diversity – in this basic sense, the world is viewed as self-contained autonomous system merging two qualities; the sustained synthesis of novelty and elastic responsiveness to external influence.

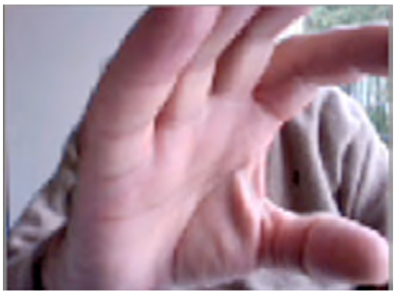

Fig. 2. Current image.

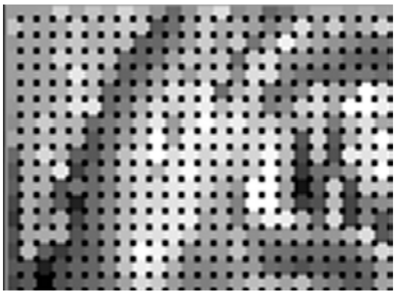

Fig. 3. Inter-frame changes.

Fig. 4. Image memory.

Fig5. Angle of current change.

Notice the implicit nature of our fitness function; any particle within the zone is considered a potential parent though the first two that manage to get within that zone earliest on (in a given process cycle) are effectively designated as parent objects. The reproduction process addresses the reproductionTable – a data structure holding all legitimate breeding options within a four-gender format. Offspring objects merge their parents' parametric data by way a crossover operator and mutation is added in order to avoid convergence.

A particle holds five items of parametric data considered control variables of a frequency modulation software synthesizer running on the Supercollider sound server engine; (1) carrier frequency, (2) carrier partial, (3) modulation partial, (4) modulation index and (5) amplitude. As time goes by, the evolutionary process echoes in the sound produced by the installation as a whole. In addition, some parameters may receive further articulation in the sound scheduler process, as described next.

Particles consult their neighbours in order to produce sound. Control parameters are computed from the consideration of a specific particle and its given neighbouring particles; sound is generated when (1) the total number of neighbours exceeds the minimum number of neighbouring particles threshold, (2) the neighbour has actually moved in space over the last process cycle, (3) it has not output any sound in the last 10 seconds. A mapping algorithm imposes additional articulation on the sound controlling parameters (as identified by the breeding process) the xy-position to respectively carrier-frequency and modulation-frequency – the other three sound parameters remain untouched. In other words, a genetic algorithm conditions the timbre qualities of sound (within a given epoch) while particle position exerts impact only on frequency parameters.

Many parallel dynamic visualisation processes contribute to a life-like inclusive display. Particles are visualised according to their gender, sensitivity, current state and location. The trajectory of the centroids of the circular zones of human influence is traced in 2D space. Neighbouring particles are visualised as variable clusters using line segments. Occasional super-structures emerge; when a particle has at least three neighbours, a curve object is visualised inclosing all neighbours in question.
One may think of the visualisation process as another instance of emergence; a critical mass of systems modules contribute visualised data and, while taken as a whole, all contributions coalesce to offer the perception of a complex life-like synthetic universe.

Figure 2 shows the image currently captured by the camera. Figure 3 displays the amplitude of the local differences between any two consecutive camera frames. It shows the absolute values of the changes as mapped to a grey scale image. Figure 4 reflects the accumulation of successive changes accommodated in a dynamic memory structure. Figure 5 displays the way the centroids of external activity change in the physical world; the locations of the trail are mode visible proportional to their strength and the angle (the direction of change) if equally depicted by a red vector.
As mentioned above, visualisation in Petri reflects (1) the internal values of instance variables inside individual particles and (2) follows from the local interactions between spatially neighbouring particles.

The current status of particles' instance variables is reflected in their visualisation. For instance, when particle status equals 1 (i.e. awake), visualisation is simply a coloured dot. When within the zone of human influence and given maximum sensitivity a complementary white circle is displayed. The green circle marks the centre of the history trail of human activity.

The interaction between individual particles is also status (awake or asleep) dependent. For any particle, when awake and the distance to any other particles is smaller than its neighbouringSensitivity parameter, its velocity will slow down and, when below a given threshold, its status will switch to 0 (asleep) and this momentary event will signalled by a flashing circle. When the particles happens to be asleep and the sleep-time is over, its status will switch to 1 (awake) and this event similarly triggers a visual spark.

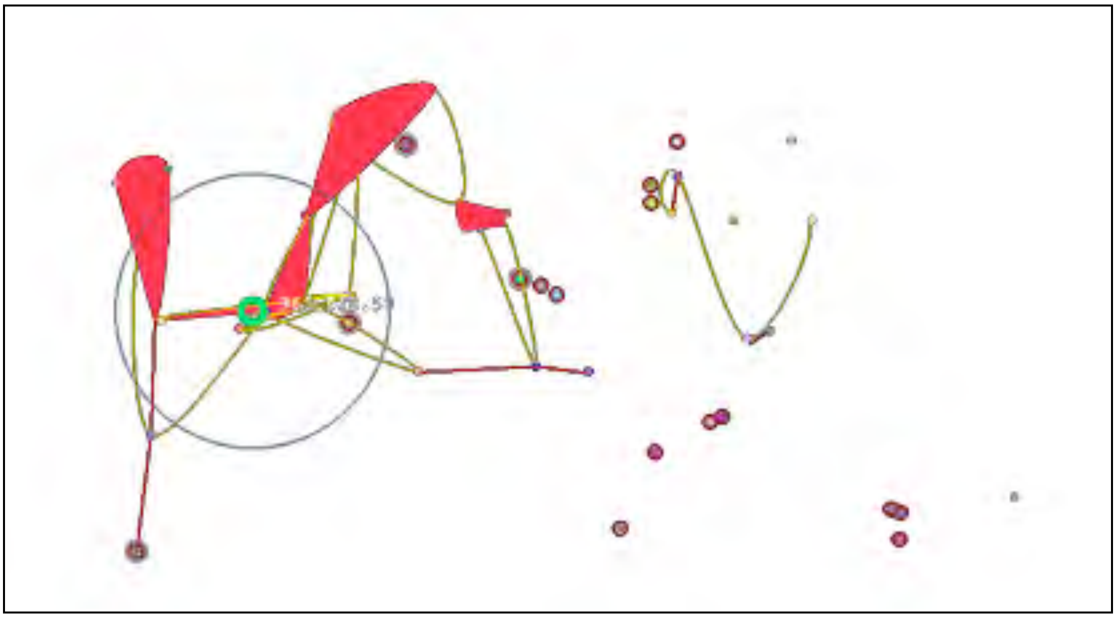

Fig. 6. Prototypical clustering of interacting particles within the zone of influence (the blue circle) (colour inverted).

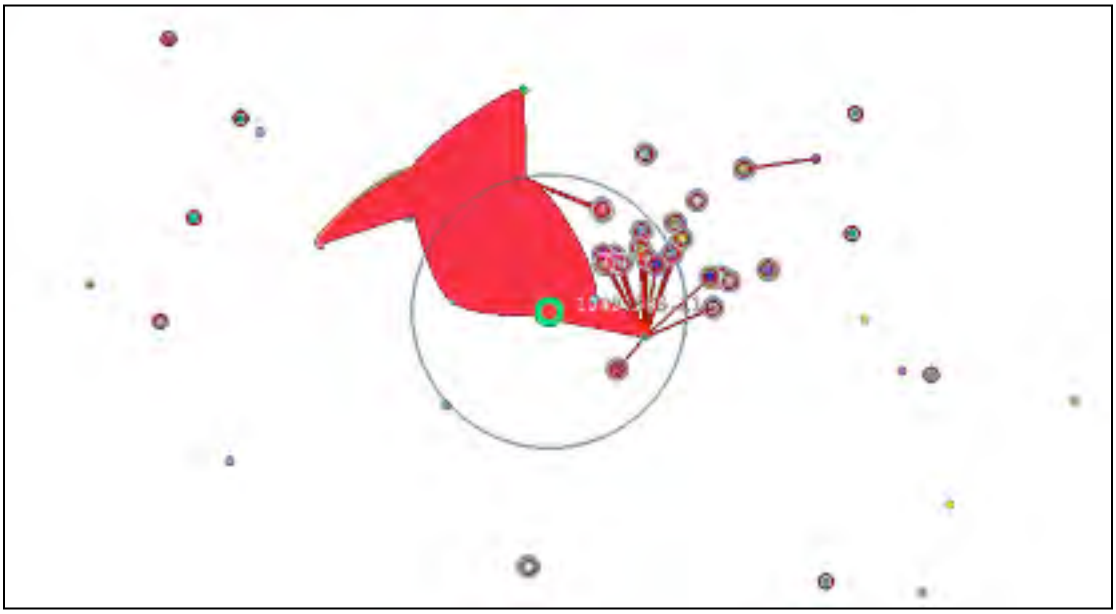

Fig. 7. Visualisation emerges from the consideration of particle status and current neighbourhood (colour inverted).

Further particle visualisation echoes its number of neighbours. When a particle features three particle neighbours, a red blob will enclose them, given more than 3 neighbours, a yellow curve will connect them. In case of just one neighbour, a line segment is drawn between the particle and its neighbour. As shown in figures 6 and 7, complex dynamic visualisations emerge as a consequence of the fluctuations in status, position and sensitivity of the current particle population in the world.

4. Discussion and conclusion

Petri can be seen as a crossing point between nature and culture in the sense that a synthetic universe is interfaced with the physicality of the natural world.

This project was first shown in Spring 2010 at the Update II international exhibition of New Media Art in Ghent, Belgium and was nominated for the Liedts-Meesen New Media Award. People express fascination by the continuous generation of audiovisual novelty while – at the same time – the system keeps a structural integrity. Remarkably, many “visitors” of the installation feel urged to capture the attention of the system by engaging in exaggerated bodily behaviour such as vigorously waving their hands. Their idea of “participation” lends towards exercising control over a self-organising process in continuous flux. Incidentally, many people expect dealing with a responsive (rather than an interactive) system much like interacting with a computer game in which clear mappings exist between user gestures and machine responses – a computer game is said to be transparent to the user. Petri does not aim for transparency but rather suggests the interaction paradigm of mutual influence.

Few systematic studies exist aiming to connect social processes in contemporary society with scripted processes in artificial societies. Human social processes are rooted in cultural histories, unconscious and mainly hidden from deliberate observation. However, spontaneous human social group behaviour might externalise dynamic patterns reflecting deeply hidden cultural logic. The work reported here is a first step in challenging that logic with invented/artificial logic though more systematic experiments are obviously compulsory.

A short note on implementation: Petri exists as two concurrent software modules. Visualisation, computer vision and interaction are implemented in Processing (Fry & Reas 2007). Real-time sound synthesis is handled by James McCarthy’s outstanding Supercollider programming platform (Wilson et al. 2011). Data transfer between Processing and the sound server running in Supercollider is handled by OSC (Open Sound Control).

In conclusion; Petri exists as the suggestion of a temporal interface between a virtual, autonomous world populated by simple creatures and a specific physical world inhabited by humans. It exists as a playground and expresses faith in the idea that rewarding human-machine interaction may emerge from the articulation of human originated influence over an otherwise autonomous process. This approach is in eminent conflict with most commonly observed interaction protocols that imagine accurate control over a given process. In contrast, the project documented in this paper views spontaneous bodily behaviour of a human participant as complementary to the internal behaviour of an artificial world.

This parallel, synthetic universe is thought of as a distributed system consisting of a population of basic entities called particles. Particles interact locally using very simple rules. However, when considering the population as undivided, simple local interactions give rise to interesting, complex global behaviour that could not be anticipated by the systems designer – emergence is said to happen implicitly without the need for global explicit human-engineered guidelines.

Human “participants” (rather than “interactors”) may develop a degree of sensitivity and fractional understanding of what is actually happening inside the population of interacting particles. However, they may never really develop a complete understanding of the installation in its entirety, even given repeated visits. This particular mix of meaning and mystery acts as a source of rewarding human-machine interaction; the idea of interaction itself is extended into a profound, machine mediated aesthetic experience.

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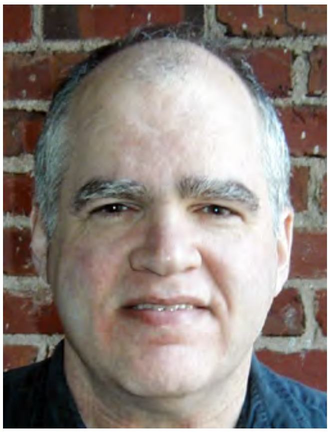
Philip Galanter

Paper: **Generative Art after Computers**



Topic: Fine Art

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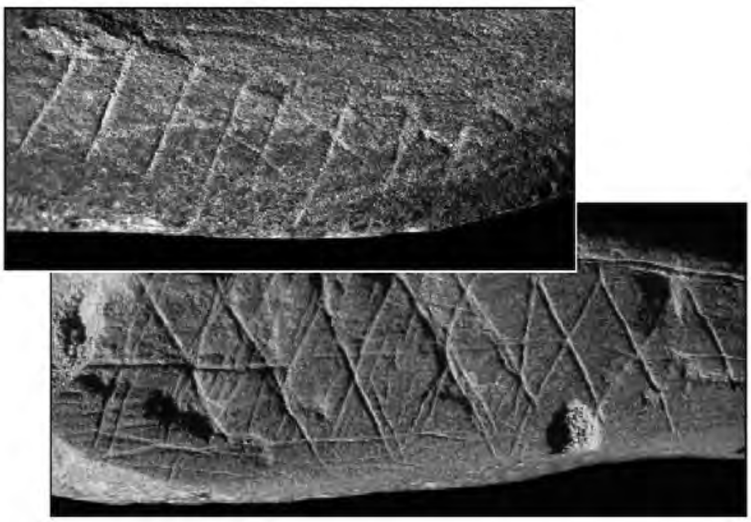
Abstract:
While most art theoretical discussions of generative art acknowledge that it is not a practice limited to digital means, in popular use the term is frequently used as a reference to a kind of computer art. From a broader view generative art as a systems-based practice can be found in ancient art exploiting symmetry, tiling, and patterns. In the mid-20th century stochastic systems were added to the mix, and in the late-20th century systems found in complexity science came to dominate.

What ties all of these art practices together as generative art is not merely the use of generative systems, although that is the defining feature of generative art. All of these practices also suggest a number of common art theoretical questions. For example, if the artist gives up control to an external system, how does that problematize the issue of authorship? Can generative systems themselves be considered creative? And indeed is generative art really art at all?

If generative art is more than just a form of computer art then one would expect to not only find generative systems in use prior to the advent of the computer, it seems reasonable to expect that new technologies and systems will be brought into play after computers. This paper explores how technologies such as synthetic biology, nanotechnology, and smart materials may represent the future of generative art. This is given substance by demonstrating that the art theoretical questions one encounters up through computer-based generative art will apply equally well to these new generative systems.



Oldest known generative art, approx. 75,000 B.C. found in South Africa

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Keywords:
Computer art, complexity, aesthetics, synthetic biology, nanotechnology

Generative Art after Computers

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Premise

While most art theoretical discussions of generative art acknowledge that it is not a practice limited to digital means, in popular use the term is frequently used as a reference to a kind of computer art. From a broader view generative art as a systems-based practice can be found in ancient art that exploits symmetry, tiling, and patterns. In the mid-20th century stochastic systems were added to the mix, and in the late-20th century systems found in complexity science came to dominate.

What ties all of these art practices together as generative art is not merely the use of generative systems, although that is the defining feature of generative art. All of these practices also suggest a number of common art theoretical questions. For example, if the artist gives up control to an external system, how does that problematize the issue of authorship? Can generative systems themselves be considered creative? And indeed is generative art really art at all?

If generative art is more than just a form of computer art then one would expect to not only find generative systems used prior to the advent of the computer, it seems reasonable to expect that new technologies and systems will be brought into play beyond computers. This paper explores how technologies such as synthetic biology, nanotechnology, and smart materials may represent the future of generative art. This is given substance by demonstrating that the art theoretical questions one encounters up through computer-based generative art will apply equally well to these new generative systems. This provides an argument supporting the notion that digital generative art should be considered a subset of generative art.

1. Generative Art to Date

In previous writing I've offered the theory that while generative art is frequently thought of as a form of computer art, it is more accurately thought of as a way of making art that is independent of any particular technology. I've also noted that in fact that generative art is as old as art itself, and that the notion of effective complexity provides a framework for organizing generative systems. This is illustrated in figure 1. [1, 2]

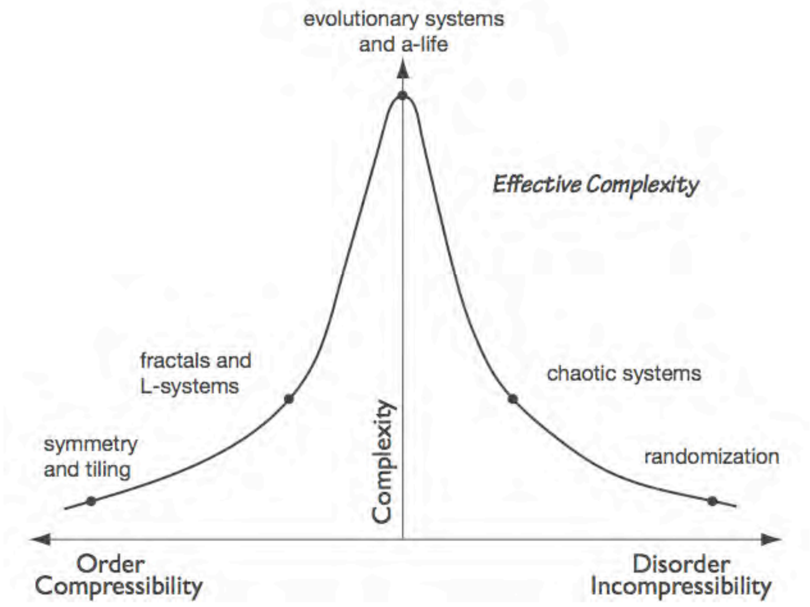

Figure 1 - Generative systems organized by effective complexity

Other writers have tended to agree that computers are not a requirement when making generative art, but they nevertheless quickly shift emphasis to what I would call *digital* generative art. For example, Boden and Edmonds allow a place for *non*-digital generative art:

> Not all generative visual art involves computers. Pre-computer examples include such clear cases as Kenneth Martin, whose 1949 abstract painting used basic geometrical figures (squares, circles, diagrams) and rules of proportion (Martin 1951/1954). Later, his 'Chance and Order' and 'Chance, Order, Change' series combined rule-driven generation with random choice.

But they go on to note:

> Today, the term 'generative art is still current within the relevant artistic community. Since 1998 a series of conferences have been held in Milan with that title (Generativeart.com) and Brian Eno has been influential in promoting and using generative art methods (Eno 1996). Both in music and in visual art, the use of the term has now converged on work that has been produced by the activation of a set of rules and where the artist lets a computer system take over at least some of the decision-making…[3]

It's worth noting, however, that both the Generative Art Conference and Brian Eno at times have featured non-digital generative art methods.

The purpose of this paper is to posit and defend two propositions. First, while generative art can be simply defined as a systems-based art making practice, all generative art also suggests a common set of unique problems. The consideration of these problems is remarkably similar whether or not the system in question is digital. In addition these problems do not apply to non-generative art in the same way. This encourages bonding digital and non-digital generative art tightly into the common family of generative art.

The second proposition is that we are on the verge of developing new generative systems that are not digital, i.e. there is new generative art after computers. These new non-digital forms will also engage the problems referenced in the first proposition, and therefore reinforce the first proposition.

1.1 Theories of Generative Art versus Theories of "Good" Generative Art

It is worth noting that there are a number of competing theories about generative art and its definition. Informally some of these might be summarized as follows:

- Generative art involves the use of randomization in composition.
- Generative art involves the use of evolutionary systems to evolve form.
- Generative art is art that is constantly changing over time while on display.
- Generative art is art automatically created as variations of a central idea

A version of this last theory is often championed by Celestino Soddu, the primary organizer of the Generative Art Conference. Quoting from the call for proposals for the 2012 Conference:

> Generative Art is the idea realized as genetic code of artificial events, as construction of dynamic complex systems able to generate endless variations.
>
> Each generative project is a concept-software that works producing unique and non-repeatable events, like music or 3D Objects, as possible and manifold expressions of the generating idea strongly recognizable as a vision belonging to an artist / designer / musician / architect /mathematician.

The encoding of an artist's vision as a system is certainly a valid approach to generative art, but it isn't the only valid approach. For example, in some cases the artist creates a system without a pre-existing vision of what the result should be. The artist then explores the system as a new territory and discovers treasures here and there along the way.

There can be a similar confusion when discussing theories of art itself, i.e. trying to answer the question "what is art?" You can imagine a fan of Vermeer taking a look at a Pollock drip canvas saying "that's not art!" In philosophical aesthetics there are many theories of art, and in approximate historical order these include:

- Art as representation
- Art as expression
- Art as form
- Art as experience
- Art as open concept and family resemblance (neo-Wittgensteinianism)
- Art as institution
- Art as historical definition [4, 5]

Over time the definition and scope of art has broadened. By any modern standard the works of Pollock are obviously art. What the Vermeer fan should have said, and what is at least arguable, is "that's not *good* art." And in fact for most contemporary notions of aesthetics the bar for qualifying as art is rather low, but the bar for qualifying as good art is much higher and more contentious.

In a similar way some generative artists or critics have such a crisply defined opinion as to what makes for good generative art they are prone to dismiss other kinds of generative art as not being generative art at all. But like art itself, the bar for what qualifies as generative art is rather low (use of an autonomous system), but the bar for what qualifies as good generative art is quite a bit higher and more contentious.

For the purposes of this paper the term generative art, unless further modified, will be taken to mean generative art in the broadest sense; simply a way of making art using both digital and non-digital autonomous systems.

2. Hypothetical Generative Art After Computers

Two nascent technologies that hold promise for new forms of generative art are synthetic biology and smart materials using nano- or micro-technology. Both promise a similar opportunity to work with very small scale components capable of self-assembly and emergent behavior perceptible at human scale. In the following sections hypothetical generative artworks will be described. While these hypothetical pieces are plausible long-term extensions of current research, no claim is made that these hypothetical pieces are currently within reach or even accurate predictions of future pieces. For the purposes here it is sufficient that in principle such artwork might be created.

2.1 A Hypothetical Dynamic Mural Made Using Synthetic Biology

Synthetic biology draws from life science to create new organic systems typically starting at the level of DNA sequencing and synthesis. In some cases existing DNA is used and modified, and in others new DNA is built from scratch. Projects such as the BioBrick initiative can now provide standardized DNA sequences as building block components that can be incorporated into living cells such as E. Coli creating new forms of biology not found in nature. [6]

Some indication of what the future may bring is offered by the E.Chromi project at Cambridge University. Researchers there genetically engineered E. Coli with additional genes creating biological machines that can sense various chemicals and then synthesize pigments of various colors. One application is the creation of easy-to-use tests for environmental hazards. For example, one strain might detect arsenic in ground water and produce a red pigment when it is found. Another strain might detect mercury and produce green pigment. [7]

For future generative art one can imagine creating dynamic murals made with thin layers of living cells that can be painted on to a wall. The cells would detect and message each other, exercise nonlinear dynamics, and self-organize creating ever-changing emergent patterns of color.

2.2 A Hypothetical Sculpture Made Using Nano-, Micro-, or Millimeter Scale Smart Materials

Nanomachines are molecule-sized machines that are a few nanometers (10^{-9} of a meter) in size. Micromachines are 1000 times larger and so are measured in micrometers (10^{-6} of a meter). Work 1000 times larger yet can lead to machines at the millimeter scale. Nano-, Micro-, and Milli- technologies are currently very broad areas of intense development. One area is that of robotics. It has been speculated that this may one day lead to the creation of self-assembling materials. This might yield a sand-like material where grains sense, communicate, and navigate across each other and then bond creating emergent 3D shapes at human scale.

A number of much larger self-assembling robots have already been created. Examples include the Swarm-bots of Gross, Bonani, et al, and more recently the smart pebble robots of Gilpin and Rus. [8-10] The smart pebbles have demonstrated the ability to surround an object and then copy its shape by bonding other pebbles.

For future generative art one can imagine a smart material that begins as a kind of sand where each grain is a tiny machine. Then through massively parallel transactions the grains intelligently fuse themselves together to create a sculpture.

3. Problems in Generative Art Theory

What will be argued in the following section is that both digital and non-digital generative art past, present, and future all suggest a common set of art theoretical questions. It will also be argued that these same questions are trivial, irrelevant, or framed differently in the context of non-generative art.

In the case of generative art reasonable people can have differing opinions as to how these questions should be answered. What is important here is not settling on a single answer for each question, but rather to recognize that each is a salient issue for all forms of generative art, and at the same time not terribly relevant to non-generative art.

For the purpose of discussion we will use the hypothetical smart material sculpture and hypothetical synthetic biology mural as examples of future non-digital generative art. As an example of past digital generative art we will use the evolutionary art of William Latham. Latham, along with programmer Stephen Todd, created what was probably the first software based evolutionary system for the creation of fine art images. [11] As an example of past non-digital generative art we will use the dynamic minimal sculpture Condensation Cube by Hans Haacke. Haacke sealed a plexiglass cube with a thin layer of water at the bottom. Reacting to the ambient heat and air currents in the gallery, this simple system evaporates the water and then creates ever-changing patterns of condensation on the cube walls. [12]

Figure 2 - Artwork by William Latham

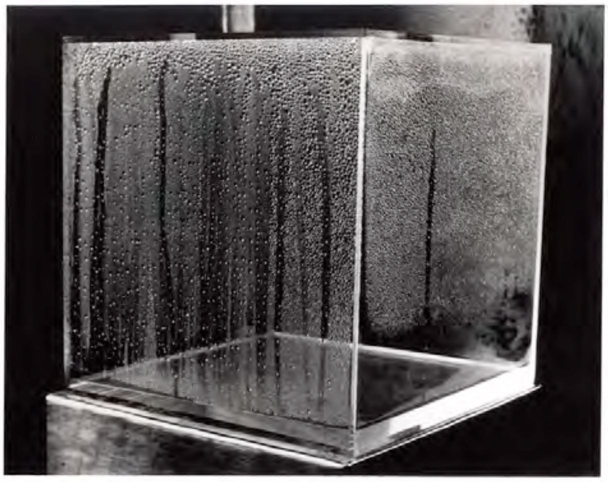

Figure 3 - Artwork by Hans Haacke

An an example of contemporary digital generative art we will use the fractal flame animations of Scott Draves's Electric Sheep. And finally as an example of contemporary non-digital generative art we will use the physical fractal art of Brian Lytle. Lytle floats fine metallic powders on water where it is held and distributed by surface tension. The differing densities of different powders cause interactions creating fractal patterns down to microscopic scale. The water is then drained and the powder is laminated on a support and covered with a sealant. In some ways Lytle's work anticipates future generative art made with smart materials.

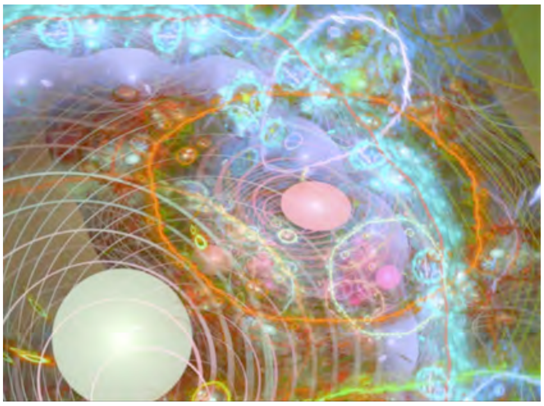

Figure 4 - Artwork by Scott Draves

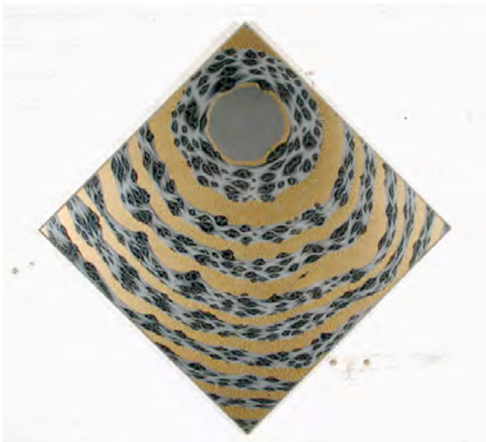

Figure 5 - Artwork by Brian Lytle

3.1 The problem of authorship

With generative art how do traditional views of the artist shift regarding credit, expression, provenance, and so on?

When someone first encounters digital generative art a common question is "who is the artist, the human or the computer?" In artwork created without human intuition or real-time judgement many see a resonance with contemporary post-structural thinking. Some generative artists work specifically in the vein of problematizing traditional notions about authorship. [1] In documenting their ironic software artwork/application Ward and Cox quote Barthes, Foucault, Benjamin, and others to explicate what they see as the breakdown of the heroic author of modernity. [13] McCormack, Bown, et al tie the problem of authorship to those regarding agency, creativity, and intent, all problematized in generative art, but taken somewhat for granted in non-generative art. [14]

For example, in the above examples it's easy to associate the physical artifacts with Lytle or Haacke, but the patterns they display are not authored by the artist. In the case of Latham and Draves the artist or the observer can make choices, but only among alternatives created by the computer. To what extent does such selection confer authorship?

The hypothetical synthetic biology mural and smart material sculpture problematize authorship to an even greater extent in that there is no computer to compete for the title of author. The work emerges from the medium itself.

Non-generative art, on the other hand, suffers no such ambiguity. There is little doubt that the Mona Lisa was created by Leonardo and not his paint brushes. The problem of authorship for generative art is quite different.

3.2 The problem of uniqueness

Traditional art artifacts are treasured as unique objects, but when such objects can be produced in quantity does that diminish the value of the art?

In forms of non-generative art such as photography and print making there is a break from the obvious uniqueness of handmade paintings or sculptures. This has been addressed by 20th century critics with Walter Benjamin usually cited as leading the way. [15] The ability to make endless copies finds its fullest fruition in digital new media where the dematerialization of the work make duplication essentially free.

Generative art adds a completely new problem. Rather than offering an endless supply of copies generative art can offer an endless supply of unique artifacts. In principle Lytles' fractal panels could be made in an automated factory creating a different image each time. In the same way our hypothetical synthetic biology mural or smart material sculpture could be endlessly instantiated without repetition.

Unlike single edition or reproduced non-generative art, all generative art requires a discussion of the endless creation of unique objects, digital or not.

3.3 The problem of autonomy

Since the artist creates the system, and to date all such systems are presumed to be unconscious, can the system be thought of as being autonomous in the same way a human artist is?

Some will argue requiring that autonomous systems be used in generative art is a nonstarter. The systems are dependent on humans creating them, maintaining them, turning them on and off, providing energy, and so on. A possible response is that in totality even humans are not entirely autonomous. In addition the generative systems in question are autonomous within the bounds of composing the artwork.

Others argue that true autonomy in a system requires agency and consciousness, something lacking in generative systems to date. A possible response is that in this context the word “autonomy” is being used as it is in robotics. Robots are said to be autonomous when they can navigate and travel without a human “at the wheel.” There is no implication, however, that such robots have agency or consciousness.

In this sense in the examples of Lytle and Haacke, as well as our hypothetical synthetic biology mural or smart material sculpture, it’s clear that the generative systems involved are autonomous. In the case of interactive generative systems like Latham’s and Draves’s things are a bit more fuzzy. But in the case of non-generative art the problem of autonomy doesn’t enter the picture at all, e.g. we don’t question Leonardo’s autonomy.

3.4 The problem of authenticity

Given it is in part created by an unemotional and unthinking system, is generative art really art at all?

Generative art can certainly fit within the older theories of art (see section 1.1) that emphasize form or (viewer) experience. It can be only partially compatible with representation while noting that the representation theory of art excludes most non-generative modern art as well. Generative art can comfortably fit within the contemporary social-construction theories of art based on family resemblance, art as institution, or historical definition.

The most problematic theory of art for generative art is the one that emphasizes art creation as a function of subjective introspection, i.e. art as expression. Does it make sense to say that the computer, or a pool of synthetic biology, or a heap of smart material sand can and will express itself? Alternately, when the computer, synthetic biology, or smart material determines forms not anticipated by the artist, does it still qualify as the artist’s expression?

Determining the correct answer to these questions is not important here. What is important is that with regards to authenticity digital and non-digital generative art present the same challenges, and both have little in common with non-generative art.

3.5 The problem of live dynamics

Some have opined that generative art must exhibit change over time, and that static artifacts made using generative systems outside the view of the audience should not be called generative art.

Of the four examples of actual artwork only the Haacke piece exhibits generative change over time. Latham’s and Lytle’s works are static as completed, and the former is digital and the latter is not. Draves’s animations are actually rendered offline for later viewing and so the generative aspect is executed out of the view of the audience.

As described the synthetic biology mural would be constantly changing but the smart material sculpture would not. The consideration of additional examples would further underscore that both digital and non-digital generative art may or may not exhibit live dynamics.

Asking whether non-generative art should or shouldn't exhibit live dynamics is, however, a somewhat absurd question. In order to display live dynamics some kind of generative system would be required, and that would make the piece generative rather than non-generative. The problem of live dynamics is sensible and equivalent for all generative art, but doesn't make sense for all non-generative art.

3.6 The problem of creativity

Can generative art systems be considered creative when they are merely unpredictable and typically lack any self-critical capacity?

In many ways this question runs a parallel course with the problems of autonomy and authorship. Philosopher Margaret Boden has offered that "Creativity is the ability to come up with ideas or artefacts that are new, surprising, and valuable." [16] In other writing I've offered the differing view that creativity is not limited to humans or even animals. "Creativity isn't as special as some might think. All complex adaptive systems are creative." [17]

Whether our hypothetical systems of synthetic biology or smart materials are creative is a debate worth having. And the question applies equally to both digital and non-digital generative art. But there is no debate at all when it comes to non-generative art. The creativity exists in Leonardo not in his brushes.

4. Conclusion

At the time of the industrial revolution the steam engine became the reigning technology, and popular culture used it as a metaphor for all manner of purposes. In the mid-20th century atomic energy and all things "atomic" took on a similar cultural role. In contemporary culture computers and networks have become the reigning technologies to capture the imagination of the public as they spawn new applications nearly on a daily basis.

I've noted that generative art is often thought of as a form of computer art, but that there is a broader definition and theory of generative art based on autonomous systems of all kinds. Such a definition is deceptively simple in that it seems to draw a fairly bright line between generative and non-generative art based only on function. Like contemporary definitions of art, it offers a rather low bar and postpones discussions of value for a later higher bar.

But as discussed above digital and non-digital generative art are equally problematized by a set of common aesthetic issues. In addition, those same issues apply quite differently or not at all to non-generative art. Restricting the descriptor "generative art" to only digital generative art privileges a technology that happens to temporarily have a cultural caché. However, future non-digital technologies will yield new generative art that engages many of the same issues that current and past generative art do.

It's natural that programmers making generative art would want a banner for their activity. But words are tools and the term "generative art" is too useful to be restricted to the subset best called "digital generative art." Doing so masks the commonality of theory digital and non-digital generative art share. In addition it is short-sighted. Non-digital nascent technologies like synthetic biology and smart materials represent the likely future of generative art.

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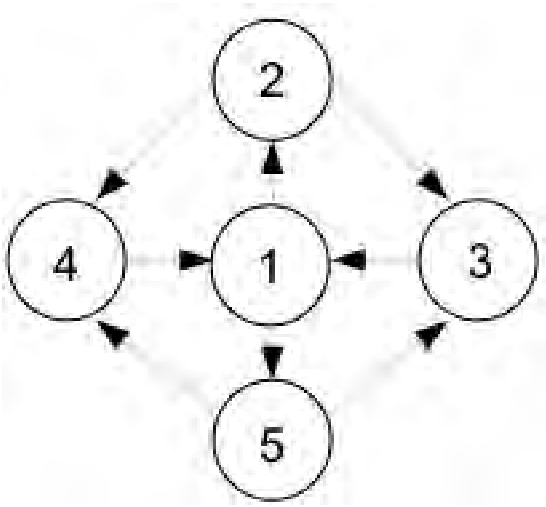
Phillip Hermans

Paper : Computer Modelling and Analysis of Goal-Oriented Acoustic Music Compositions

Abstract:

This paper will describe the design, modelling and analysis of music compositions created by the author. Goal-oriented compositions refer to musical compositions in which the performers have some goal, that they attempt to reach by following the music and instructions found within the musical score. Three such compositions are presented in this paper: a percussion quartet, a trombone octet and a percussion trio. Models of these compositions were developed in MATLAB and simulations using these models allow for testing and experimentation during the composition process and analysis after a composition is complete.

The inspiration for the music compositions is derived in part from the engineering/computer science field of networked multi-agent systems. The distributed computing algorithms used in consensus problems[1] gives rise to emergent phenomenon such as synchronization of networked oscillators or flocking behaviour [2]. The use of these concepts in musical composition lends itself to computer modelling and statistical analysis, as well as a highly variable musical output. The computer models aid in experimentation during the composition process, testing of finished compositions and analysis after performance of a work.
Statistical methods of analysis are particular useful for algorithmic and generative works due to the multitude of realizations possible. The analytical tools provided in this paper are specifically for music compositions with discrete states. Future work includes the use of statistical models for the analysis of music compositions with continuous states as well as the application of these concept to other artistic media and forms.



Planar, Connected Digraph of "5 Choose 4" Percussion Quartet

Topic: Music

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References:

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Keywords:
algorithmic composition, music analysis, consensus protocol, computer modelling, networked multi-agent systems

Computer Modelling of Goal-Oriented Acoustic Music Compositions

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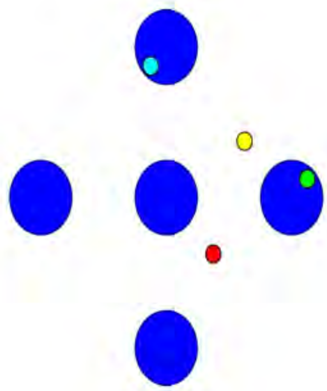

Fig. 1 Visualization of "5 Choose 4" Simulation

Introduction

This paper will describe the design and modelling of music compositions created by the author. Goal-oriented compositions refer to musical compositions in which the performers have some goal, which they attempt to reach by following the instructions within the musical score. Three such compositions, and their general models, are presented in this paper. Models of these compositions were developed in MATLAB and simulations using these models allow for testing and experimentation during the composition process and analysis after a composition is complete.

1. Background

The history of networked multi-agent systems provide relevant context for the framing of these musical compositions and their computer simulations. Examples of "networked systems" include sensor networks, swarms, gene networks, social networks, synchronous networks of oscillators, networks of autonomous vehicles, and mobile ad-hoc wireless networks. This field is built on subjects from control theory, complex networks, graph theory [1] and distributed computing. [2]

The "goal-oriented" pieces presented in this paper can be seen as analogous to consensus problems [3] from the field of computer science and engineering. A consensus protocol/algorithm is a method used by networked agents (or dynamical systems) to reach a consensus (or in this case, goal). All of the systems dealt with in this case are discrete, in the sense that all of the states can be represented by integers. For an example of discrete consensus algorithms see Kashyap [4]. A related subject, flocking, is introduced in Saber [5]. For another musical work using networked multi-agent systems see Furlanete [6].

2. Discrete Symbolic Consensus Protocol

This section will detail a composition titled “5 Choose 4”, a percussion quartet originally performed by *Sō Percussion* [7]. The composition will be presented in its original form as well as in a generalized form allowing it to be adapted to other musical ensembles or mediums.

2.1 Original Form of “5 Choose 4”

This piece is scored for 4 percussionists and 5 percussion instruments situated in a planar, connected digraph as shown below (Fig. 2).

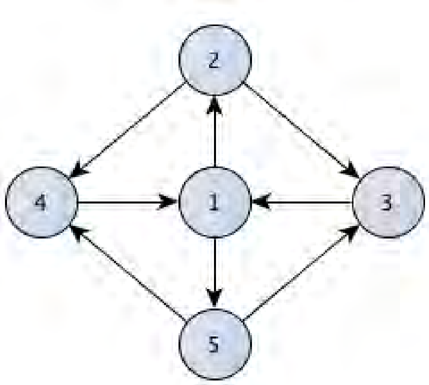

Fig. 2 Node Locations and Connections of “5 Choose 4”

Each instrument has a unique location at one of the 5 nodes. Additionally, each node has a corresponding page from the score with a list of four rhythms, each rhythm corresponding to one of the players. The rhythms (Fig. 3) are distributed throughout the network of nodes so that each player has each rhythm once at a unique location.

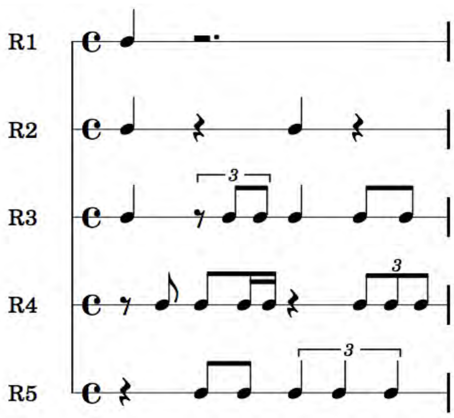

Fig. 3 Rhythms from “5 Choose 4”

The musicians begin the piece at node 1 and play their assigned rhythm in tempo with the other players. After playing the rhythm once, players may either repeat the rhythm or travel to a new node following the arrows on the map (Fig. 1). The travel time allotted to move between nodes is equal to the duration of one rhythmic phrase (one measure of music) and is hereafter referred to as one “time step”. The players may only repeat a rhythm a certain maximum number of times in a row, and must play it a certain minimum number of times. These maximum and minimum values are adjusted according to the skill level of the players and the desired difficulty of the performance. The piece ends once all of the players are playing the same rhythm in unison.

2.2 General form of “5 Choose 4”

This piece will now be presented as a symbolic consensus protocol for a multi-agent system. Each agent follows the methods outlined in the flow chart below (Fig. 4).

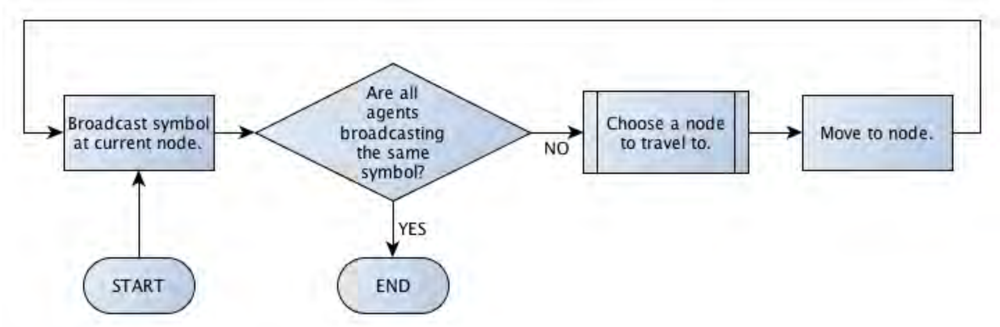

Fig. 4 Flow Chart of Symbolic Consensus Protocol

The agents carry out this methods on a planar, connected digraph with at least as many nodes as agents. Connectivity ensures that all nodes are reachable by each agent, making the digraph planar avoids collisions between mobile agents and having the minimum number of nodes be equal to the number of agents makes reaching consensus less trivial. However, it is feasible for this method to reach consensus on undirected or non-planar graphs, but not necessarily in every case.

At each node there is a symbol corresponding to each agent. In the most trivial case, all nodes have the same symbol for each agent and consensus is reached immediately. For each additional symbol added to the system there exists at least one more solution if and only if that symbol exists at at least one node per agent and there are less than or as many symbols as nodes.

Given n nodes and r agents, the amount of possible combinations is given by:

$$n^r \tag{1}$$

In “5 Choose 4”, there are 5 nodes and 4 agents. That is 625 configurations, with only 5 of those resulting in consensus.

2.3 Computer Simulation of “5 Choose 4”

The simulation was conducted in MATLAB [8]. Four different methods for the sub-routine “Choose a node to travel to” from Fig. 3 were designed. While these methods strive to reach a consensus in the simulation, it is beyond the scope of this study to try and model all of the complex behaviour that occurs within the human performance of the piece. The simulated agents also have complete knowledge of the symbol locations, while human performers must discover these through exploration. The design and performance of these methods is detailed below.

2.3.1 Method 1, “Random”

This method simply chooses any neighboring node with equal probability.

2.3.2 Method 2, “Weighted Random”

This method weights the choice of any node by taking into consideration what symbols the other agents are broadcasting. Specifically the probability of selected a node is increased by 1/n % for each n agents broadcasting the same symbol as that node.

2.3.3 Method 3, “Altruistic”

The first priority of any agent using this method is to reach the node that has the most popular symbol. If there is no clear majority leader for symbols then the agent joins the symbol of their nearest neighbor.

2.3.4 Method 4, “Selfish/Lazy”

Any agent using this method will try to stay at the same node for as long as possible, regardless of which symbol is being broadcast. Once they reach the maximum number of repetitions they simply choose a neighboring node at random.

2.3.5 Performance of Methods

A simulation was run for each method independently as well as in combination. When ran independently all agents would use one method, when combined some agents would use one method and others agents another. The most useful results are summarized in the table below (Fig. 5).

Simulation of Symbolic Consensus Protocols for 1000 Trials					
	Min	Max	Med	Mean	% Consensus
M1 Random	5	1000	709.5000	637.8830	62.4000
M2 Weighted Random	3	1000	347	412.9000	93
M1 & M2	1000	1000	1000	1000	0
M3 Altruistic	1000	1000	1000	1000	0
M4 Selfish/Lazy	1000	1000	1000	1000	0
M3 & M4 50/50	7	545	56	75.7610	100
M3 & M4 25/75	8	1000	1000	917.7260	10
M3 & M4 75/25	5	981	69	100.3110	100

Fig. 5 Statistics of Simulations for Symbolic Consensus Protocol

The combination of the “altruistic” and “selfish/lazy” methods, with half of the agents using each method, reached consensus the fastest on average and also had the lowest maximum number of steps required to reach consensus. Combining M1 and M2 never resulted in a consensus, the agents just oscillated between two different combinations of nodes. Similar behavior was observed for M3 and M4 alone.

3. Discrete Position Consensus Protocol

This piece can be seen as a simplified version of the symbolic consensus protocol described above. As of writing this paper, this piece has not yet been premiered by human players. The simulation tools described below do allow for rudimentary sonification of the algorithmic work.

3.1 “Beau Noir Jamz” Original Form

This piece is designed to work with most combinations of brass instruments (trombone, trumpet, euphonium, horn and tuba). The total ensemble should be broken into groups of similar or mixed instruments, however horns should not mix with the other instruments. Each part gives the player a starting pitch and fingering/slide position (Fig. 6).

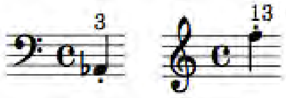

Fig. 6 Trombone and Trumpet Score Examples from “Beau Noir Jamz”

Within any sub-group of the ensemble, the goal of the players is to play the same pitch in unison. Players are allowed to depress/release one valve, or move one slide position per beat and may only repeat a given note once. Once all players are playing the same pitch, they move to the next line of the score, playing the given note. This occurs seven times before the piece is finished.

3.2 General Form of “Beau Noir Jamz”

This piece has the same general function as the flow chart for “5 Choose 4” (Fig. 4). Here the symbol being transmitted is the pitch of the note being played, and the nodes are the slide positions or valve combinations. Thus the trombonists can be thought of as agents, hereafter referred to as T-agents, traversing a line with seven discrete positions (Fig. 7).

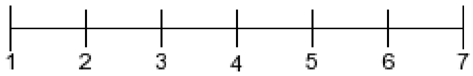

Fig. 7 Line With Seven Discrete Spaces

All of the valved brass instruments can be thought of as agents, hereafter referred to as V-agents, traversing a three-digit binary cube (Fig. 8).

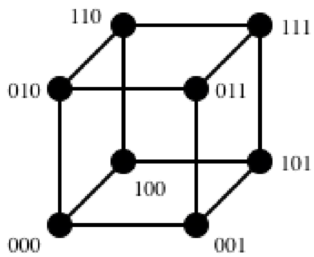

Fig. 8 Three-Digit Binary Cube

At its basic level, there is a simple mapping of the eight three-digit binary codes to the seven discrete points on the line.

Trombone Position to Valve Combination Mapping

Trombone Positions	7	6	5	4	3	2	1
Valve Combinations	111	101	011	110	100	010	000
Alt. Valve				001			

Fig. 9 Simple Mapping of T-agent Symbols to V-agent Symbols

If V-agents and T-agents are not mixed, then this becomes merely a consensus of position, rather than a consensus of symbols. That is, V-agents only need to match binary strings, and T-agents the single integer. For T-agents there are seven possible positions for each agent, so the total number of combinations between all agents is the same as equation 1, with n = 7 and r = the number of agents, with seven possible combinations resulting in consensus. The same is true for V-agents except that n = 8.

3.3 Computer Simulation of "Beau Noir Jamz"

In this simulation different trials were run for groups of four agents. T-agents and V-agents were both simulated alone. Since this interpretation of the score is framing the system as a position consensus, the T-agents and V-agents will not be combined in any trials. While this is possible in simulation, it is not anticipated to be practiced by human performers and therefore is not considered. The methods used will be described below followed by their performance.

3.3.1 T-agent Methods

M1 averages the current position of all of the other agents, and then rounds this number off to the nearest whole number. The agent then moves one step in the direction towards that value, or stays in the same position if it is the same value. The "random" method simply chooses to increase or decrease the current position with equal probability.

3.3.2 V-agents Methods

M1 calculates the average three-digit binary string of all the other agents. This string is compared to the current valve combination of the agent and if there are any differences, one bit is flipped accordingly. The "random" method chooses one of the three digits at random and then flips the bit.

Simulation of Position Consensus Protocols

	Min	Max	Med	Mean	% Consensus
M1 T-agents	1	10000	4	383.7360	96.2000
M2 T-agents	1	1763	196	286.1330	96.5000
M1 & M2 50/50 T-agents	1	133	15	20.7440	100
M1 & M2 75/25 T-agents	1	36	6	7.2810	100
M1 & M2 25/75 T-agents	1	580	59.5000	66.3900	100
Valve M1 & M2 V-agents	2	148	15	20.9270	100

Fig. 10 Statistics of Simulation for Position Consensus

For the T-agents the best performance came from three agents using M1 and one agent using the random decision making. The random decision making helps to break the agents out of any infinite oscillations between positions that may arise, lowering the maximum, medium and mean values for the trials. The V-agents had the best performance with the same combination of M1 and random choice for the same reasons as the T-agents.

4. Consensus of Discrete Time Delays

This section is about a piece “Cinque” originally orchestrated for a percussion trio with the initial performance done by TIGUE [9]. A description similar to the original score as well as the computer simulation will be described below.

4.1 Original Form of “Cinque”

In this piece players are allowed to choose which phrases they play from a given selection of music staves aligned vertically. The musical phrases are of different lengths, and once a player reaches the end of a chosen phrase they move on to the right reading the next phrase or selecting from another group of phrases. There are also “token phrases”, found within a box, which are played by all players. The goal of the players is to play these token phrases in unison.

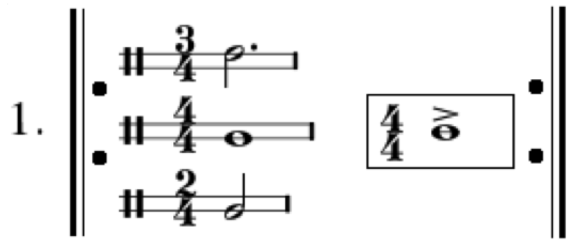

Fig. 11 First Movement of “Cinque”

The difficulty of the piece progresses as it moves through the five movements, adding token phrases, increasing the tempo and the number of different instruments employed. This culminates in the final movement which requires playing five different token phrases in unison consecutively.

Fig. 12 Fifth Movement of “Cinque”

4.2 General Form of "Cinque"

This basic behavior of one agent in this system is outlined in the flow chart below.

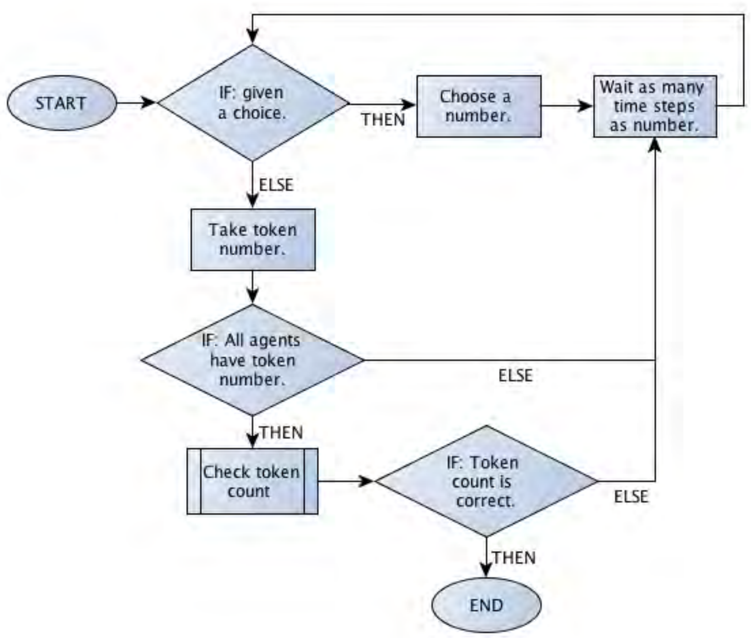

Fig. 13 Flow Chart of Discrete Time Delay Agent

This general model is adaptable to a variety of scenarios by explanation of the sub-routine "Check token count". If the agents need to simply reach one token number then the checking the token count is trivial. However, if there are multiple token numbers within the system than the check token count subroutine must keep a running total of previous token counts, the routine is outlined below.

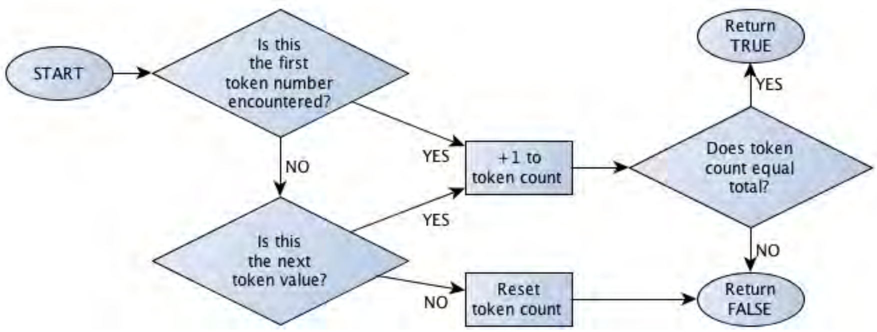

Fig. 14 Sub-routine "Check Token Count"

4.3 Simulation of “Cinque”

The simulation of “Cinque” proved difficult as the author did not to come up with any simple strategy for the agents to employ. Therefore each agent randomly choses any length phrase with equal probability. The results of this method for 10,000 trials for each movement are shown below.

Simulation of Cinque

	Min	Max	Med	Mean	% Consensus
Mov 1	1	4138	313	509.2800	83.7000
Mov 2	4	5153	645	925.4600	65.1000
Mov 3	8	10000	1.4785e+03	2.2347e+03	38.1000
Mov 4	5	2035	220	307.8450	96.7000
Mov 5	6	1266	108	157.8780	99.9000

Fig. 15 Statistics for Simulation of “Cinque”

5. Discussion

The simulation of these pieces is useful during the compositional process as it allows the composer to test ideas and experiment with different parameters of the piece. It may also give confidence that a consensus will be reached without having human performers test the piece. Additionally sonification and visualization (Fig. 1) of pieces is possible, again without the use of human performers.

Once these goal-oriented pieces are performed by humans there are many subtle differences and idiosyncrasies that are difficult to model. One of these differences observed during the performance of both “5 Choose 4” and “Cinque” is cheating. That is, doing things explicitly against the rules outlined in the piece. This is not considered to be detrimental to the performance of the piece, often times it is essential in ensuring that a piece will end in a timely manner.

Specifically, during the performance of “5 Choose 4”, two behaviors were observed that aided in reaching a consensus, but these behaviors were not present in the simulated agents. The first of these was going the wrong direction from one node to another as seen on the map (Fig. 2). Most likely this was a mistake rather than conscious defiance of the rules described, however it was not an intended action by the composer. The second behavior that was observed was verbal communication between the performers. While this was not specifically outlawed, it does go against a mechanism of the piece being a team-based listening exercise. These human errors and adaptations enhanced the entertainment value and interest of the performance by giving it a much more realistic feel than the robotic computer simulations.

When “Cinque” was rehearsed the players adapted strategies to reach a consensus at any time of their choosing. By simply cueing on another they would all jump to a specific part of the score and play a pre-determined group of phrases so that they would align on the token phrase and play it in unison. Again, this is not explicitly against the rules and it does indeed help the performance as they can adapt the piece to fit into any time scale.

Cheating, in this sense, helped the players to reach a consensus more quickly. Indeed, the human players for both “5 Choose 4” and “Cinque” outperformed, on average, the best computer simulated methods. The subtle communication between ensemble members and trained musicians is very difficult to model accurately. This compounded with breaking rules allows humans to reach a consensus more quickly than the rudimentary agent protocols designed by the composer.

6. Conclusion and Future Work

The goal, from the composer's perspective, of these goal-oriented pieces, is to give the musicians a simple system or method to follow from which music emerges. Simulations of these pieces allow a composer to observe the multitude of realizations possible giving one an ability to analyze the collection of pieces rather than each piece individually. These models also serve as a proof of concept for a piece and an experimental playground for system design and composition.

It is the author's belief that the tools and general concepts presented here can be used in a variety of other mediums not limited to the arts. The strong connection of these works to engineering and the sciences allows for potential insight into real-world phenomenon that is perhaps unavailable through standard practices. As these ideas are further refined and developed it is hoped that they will better represent processes found in nature and technology.

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Quinsan Ciao

Metaphoric and Symbolic Representation in Design Generative Scheme - Yangzhou Pu Harding Urban Redesign/Regeneration

Topic: Architecture

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Abstract:
Design is a heterogeneous process – approaches, strategies and methodologies are often influenced by the designer's own experiences, and socio-cultural background, as well as by the technical and economic conditions. On the one hand, it draws on individual intuitions, while on the other, a strong and effective design process is often grounded in some innovatively methodical and organizational concepts and schemes, which is pertinent to the basis of the generative design processes.

In popular perception and practice, particularly with sites and context of important cultural/social/religious history, urban buildings must reflect local identity and cultural significance, as it is faced by the designers of the project of redesign and regeneration of the Pu Harding Garden area located in Yangzhou – 300 km from Shanghai. The site has significant Chinese-Muslim heritage, and positioned along the ancient Chinese Grand Canal. The key issue is about how to design in representing the historical and religious culture with proposed solution, a multi-mixed use building complex with street façade. Treating cultural identity as an extra-building design idea that derived not from the programmatic concerns, initiate a metaphoric or symbolic parallel proven to be meaning and worked as a central organizing scheme to fuse together the complex phenomena of site, circumstances and program. Several proposals with various such generative schemes are included in this presentation, emphasizing the process and breeds of the initial concepts as working principle, and the evolving of its unique meaning and intensity.

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Keywords:
Design Generative Scheme, Design Methods, Concepts, Muslim Architecture, Urban Redesign, Cultural Representation

Rémi Ronfard

Paper: **Generating 3D Scenes in the style of Keith Haring.**

Topic: Visual Grammar

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Abstract: Recently, interest in shape grammar models of pictorial style [1,2] has been revived by the success of generative modelers for buildings and cities [3]. Stochastic methods have been introduced for learning the parameters of shape grammars to adapt to different architectural or visual styles, including Mondrian [4]. We extend that approach for generating 3D graphics in the style of Keith Haring paintings, whose visual vocabulary is significantly more complex than Mondrian. Our system is based on a three-tiered stochastic plex grammar [5] which decomposes scenes into figures, figures into characters and characters into body part surfaces, following a methodology adopted from art historians [6]. Each tier of the grammar is stochastic, which allows us to generate a variety of scenes in real time, while keeping the overall style of Keith Haring paintings. Because the scenes are generated as 3D graphics, we are able to animate them into generative "Keith Haring movies".

Randomly Generated 3D Scenes in the style of Keith Haring.

References:

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Keywords: Shape Grammars, Pictorial Style, Plex Grammars

Generating 3D Scenes in the style of Keith Haring.

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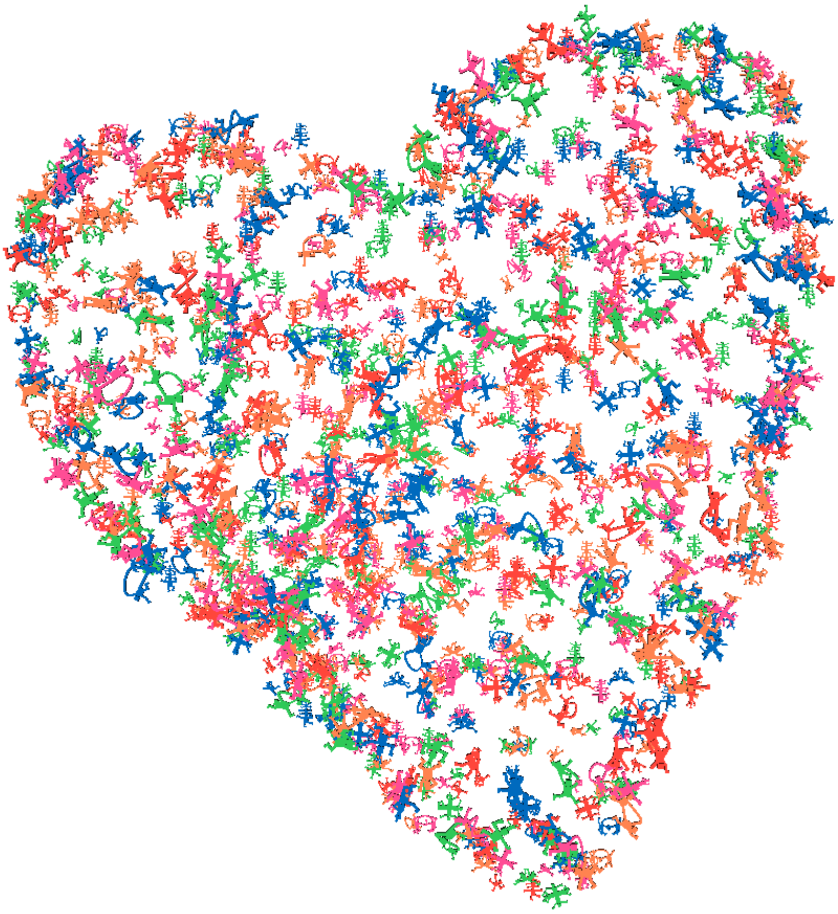


Abstract: Recently, interest in shape grammar models of pictorial style has been revived by the success of generative modelers for buildings and cities. Stochastic methods have been introduced for learning the parameters of shape grammars to adapt to different architectural or visual styles, including Mondrian. We extend those recent approaches for generating 3D graphics in the style of Keith Haring paintings, whose visual vocabulary is significantly more complex than Mondrian. We propose a four-tiered stochastic plex grammar which decomposes scenes into figures, figures into bodies, bodies into body parts, and body parts into surfaces. Each tier of the grammar is stochastic, which allows us to generate random variations of scenes while keeping the overall style of Keith Haring paintings. Because the scenes are generated as 3D graphics, we are able to animate them into generative "Keith Haring movies".

1. Introduction

Recently, interest in shape grammar models of pictorial style [1] has been revived by the success of generative modelers for buildings and cities [2]. Stochastic methods have been introduced for learning the parameters of shape grammars to adapt to different architectural or visual styles, including Mondrian paintings [4].

2. Stochastic Plex Grammars

Traditional string grammars are not adequate for building two-dimensional or three-dimensional structures. Shape grammars were introduced by Stiny and Gips [1] as a general framework for such cases, including painting and sculpture. Interest in shape grammars has been revived with spectacular results in procedural generation of cityscapes and architectural building using specialized CGA grammars [2]. Such grammars have also been extended to humanoid figures [3,4].

In this work, we use plex grammars [5] rather than CGA grammars, because they are better suited for modelling complex figures with arbitrary connections between elements, which are typical of the Keith Haring style.

As introduced by Feder [5], plex languages use a vocabulary of terminal and non-terminal *plex structures* with an arbitray number of *attaching points*. Plex grammars describe the inter-connections of plex structures in any given plex language. Typically, a plex structure A with NA attaching points can be composed with another plex structure B with NB attaching points to build a higher-level plex structure C with NC attaching points (NC < NA+NB). The plex grammar rule for such a transformation includes a list of *joints* (connecting attaching points) and *tie-points* (non connecting attaching points).

A stochastic plex grammar assigns a probability to each rule in the grammar and a probability over the list of joints and tie points in the rule. This is especially suited to the modelling of Keith Haring figures, where body parts can be inter-connected almost interchangeably. A stochastic plex grammar can also assign probabilities over other free parameters of each rule, for instance the relative distances, orientations and sizes of the left-hand side and right-hand side plex structures, but also their colors, shapes and textures.

In this work, we manually created production rules from a sample of Keith Haring paintings available on the internet. We computed empirical rule probabilities by manually labelling the grammar constituents in each paintings and counting how many times each rule was used. We also computed empirical joint probabilities by counting how many times each joint was used in its parent rule. We used the normalized counts as probabilities in all cases.

Similarly, we computed histograms of the distances, orientations, sizes, colors, shapes and textures observed in those paintings, and used the normalized histogram values as probabilities.

3. The Grammar of Keith Haring Paintings

The use of shape grammars for describing the structure of paintings goes back to at least two important papers by Kirsch and Kirsch [6] and Lauzanna et al [7] in the same issue of the Leonardo journal in 1988. This pioneering work was illustrated with examples of automatically-generated paintings in the styles of Miro and Kandinski.

More recently, Talton et al. extended the approach to stochastic grammars for generating random paintings in the style of Mondrian [3]. Their approach introduced the use of Metropolis sampling for choosing more aesthetic productions from a large number of randomly generated paintings according to a hand-tuned preference function.

We extend that approach for generating 3D graphics in the style of Keith Haring paintings [11] whose visual vocabulary is significantly more complex than Mondrian. Our system is based on a four-tiered stochastic plex grammar, which decomposes scenes into figures, figures into bodies, bodies into body parts, and body parts into surfaces.

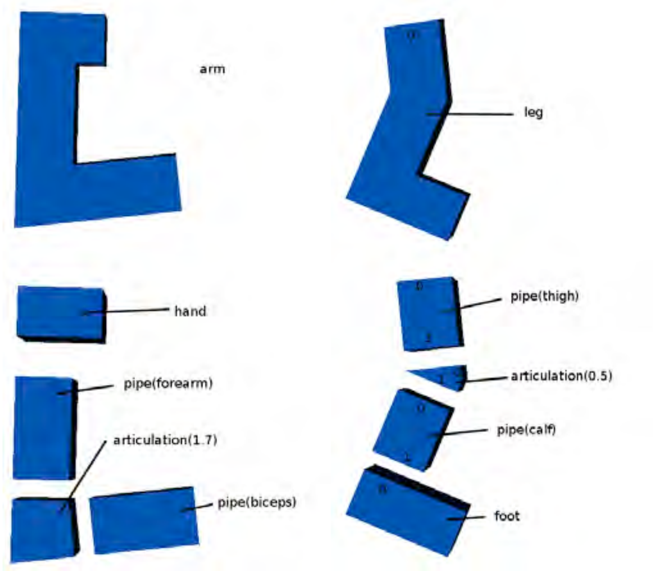
Interestingly, such structural decompositions of paintings appear to have a long tradition among art historians, starting with Alberti in 1453 [7]. According to Baxandall, such structural descriptions were originally adapted from humanist rhetoric, which praised the composition of words into propositions, clauses and sentencess [8]. Hence, Alberti praised the composition of surfaces into body parts, bodies and paintings.

What makes Keith Haring especially interesting in this context is that his paintings provide a systematic and exhaustive exploration of the combinatorial possibilities of composing figures with bodies and body parts, into very large paintings and murals. Incidentally, the combinatorial nature of Haring's style has recently been spectacularly illustrated with a 17′ x 6′ puzzle comprised of a 32,256 pieces [16].

We now turn to a tier-by-tier description of our grammar of the Keith Haring style.

3.1 Surfaces to body parts

The first tier in our Keith Haring grammar contains rules for composing surfaces into body parts. We build torsos, arms, legs and heads by assembling together tubular surfaces, as follows:

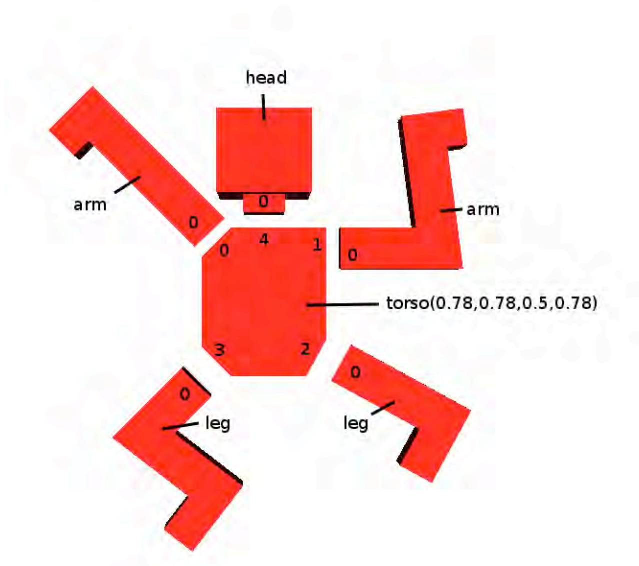


arm -> pipe(biceps) artic(1.7) pipe(forearm) hand (10xx,x10x,xx10) (0xxx)

leg -> pipe(thigh) artic(0.5) pipe(calf) foot (10xx,x10x,xx10) (0xxx)

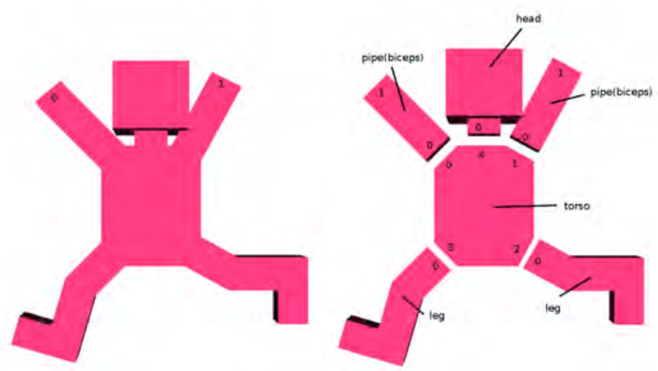
3.2 Body parts to bodies

The second tier in our Keith Haring grammar contains rules for composing body part surfaces into characters. The plex production rule for building a body is presented below.

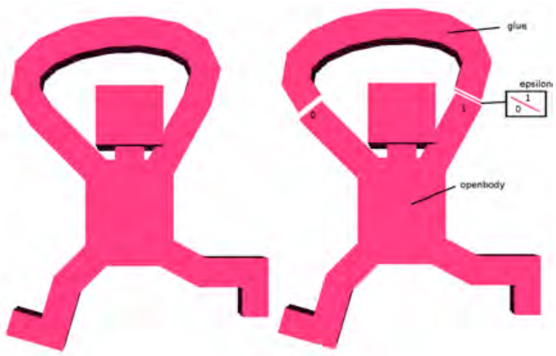


body(x,y,c) -> torso(x,y,c,0.78,0.78,0.5,0.78) arm arm leg leg head (00xxxx,1x0xxx,2xx0xx,3xxx0x,4xxxx0)

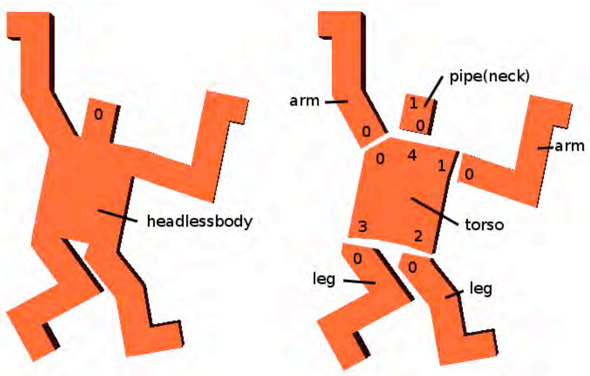
Special cases are the *open body*, where the arms contain attaching points that can connect with other bodies; the *looping body*, where the arms are connected together; the *headless body* and the *open trunk*, where the torso contains multiple attaching points that can connect to other bodies (see accompanying figures).



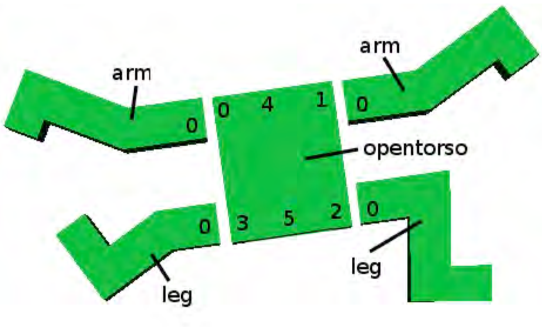
openbody(x,y,c) -> torso(x,y,c,...) pipe(biceps) pipe(biceps) leg leg head (00xxxx,1x0xxx,2xx0xx,3xxx0x,4xxxx0) (x1xxxx,xx1xxx)



looping body(x,y,c) -> openbody(x,y,c) epsilon (01,10)



headlessbody(x,y,c) -> torso(x,y,c,...) arm arm leg leg pipe(neck) (00xxxx,1x0xxx,2xx0xx,3xxx0x,4xxxx0) (xxxxx1)

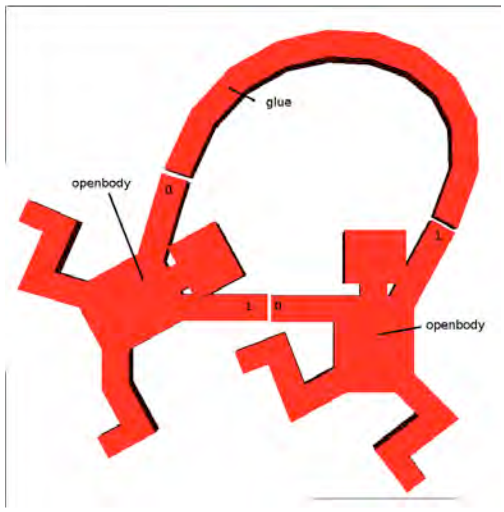


opentrunk(x,y,c) -> opentorso(x,y,c,...) arm arm leg leg

(00xxx,1x0xx,2xx0x,3xxx0) (4xxxx,5xxxx)

3.3 Bodies to figures

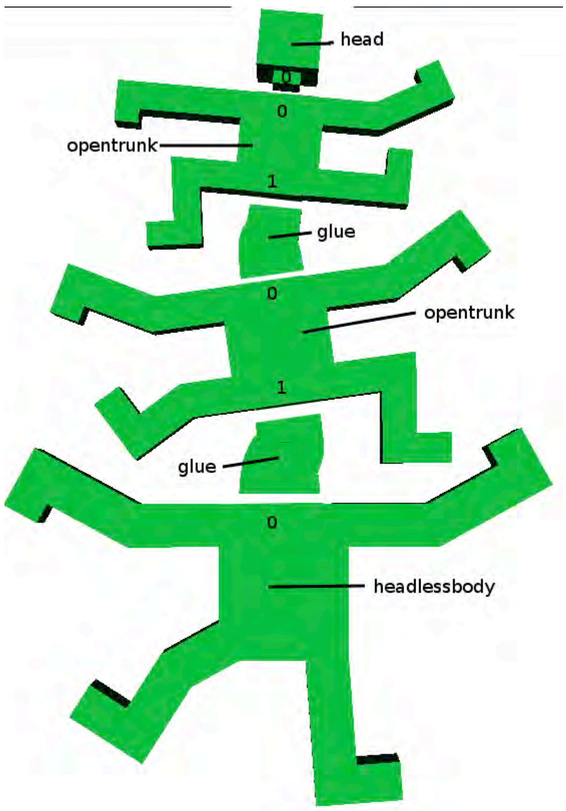
The third tier in our Keith Haring grammar contains rules for composing characters into figures. This tier demonstrates the creativity of Keith Haring with a large number of figures including couples, triplets, columns, bridges which can be combined together recursively.



couple(x,y,c) -> openbody(x,y,c) openbody (01,10)

triplet(x,y,c) -> openbody(x,y,c) openbody openbody (01x,x01,1x0)

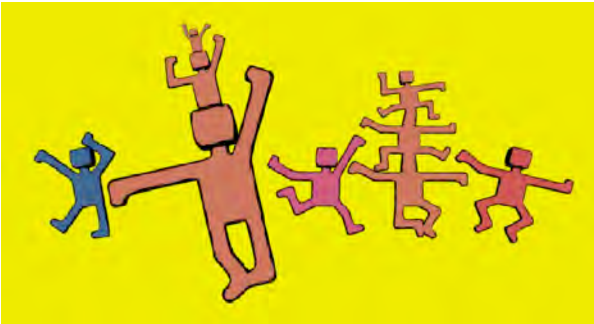
Chains are recursive structures built along the same lines ; loops are closed chains. Columns are another recursive structure characteristic of Keith Haring.



column(x,y,c,scale) -> headlessbody(x,y,c,scale)
*opentrunk(x,y+scale*0.14,c,scale*0.8)*
*opentrunk(x,y+scale*0.26,c,scale*0.64)*
head (01xx,x01x,xx00)

3.4 Figures to scenes

The fourth tier in our Keith Haring grammar contains rules for composing figures into 3D scenes. In our implementation, we only use planar figures and we place each figure by choosing the 3D location of the figure's origin and the 3D orientation of the figure's plane in camera coordinates.



4. Scene Generation

In this section, we describe how we use our grammar to randomly generate novel paintings and movies in the style of Keith Haring. Each novel scene is generated by randomly choosing rules that maximize the score of the panting with respect to a predetermined goal.

4.1 **Generative paintings**

We create novel paintings in the style of Keith Haring by generating a 3D scene and rendering it from a single viewpoint. In the following figure, we used a dart-throwing algorithm [10] to fill the planar shape of a heart with randomly generated figures without crossing or occlusion. In future work, we are planning to further extend the algorithm to also take into account other objective functions, including aesthetic or narrative goals, following the general approach proposed by Talton et al [3].

4.2 **Generative movies**

We can create movies in the style of Keith Haring by generating a 3D scene, then moving the camera and rendering the scene from the camera's viewpoint. We can also create animated movies in the style of Keith Haring by generating a 3D scene and changing it at every frame. This can be done in any different ways by inserting, deleting and moving figures relative to the scene ; by inserting, deleting and moving bodies relative to their parent figures ; or by inserting, deleting and moving body parts relative to their parent bodies. At this point, such transformations are chosen manually.

*5.*Conclusion

In this paper, we have presented stochastic plex grammars as a generic framework for representing the paintings and murals of Keith Haring and we have used that framework for generating random 3D scenes in the same style. Plex grammars appear to be ideally suited for the task. In future work, we would like to extend our approaches to other painting and sculpting styles. Another interesting avenue for future research is the generalization of stochastic plex grammars to *animation grammars* with rules describing how 3D shapes should be inserted, deleted and moved in the temporal domain to produce 3D movies.

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Robert Spahr

Paper : **CRUFT: Recent Explorations in Indeterminacy, Materiality and the Ephemeral in the Age of Mobile Media**

Topic: Computational Art and Algorithms

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Abstract:
CRUFT are images created by automated computer scripts that first download source material from the Internet, and then process this information, generating new art work 24 hours a day, 7 days a week. Beginning in 2003, early versions generated CRUFT images from the digital leftovers of the main stream media news sites using indeterminacy, genetic algorithms and the use of feedback systems. Recent work has explored the ephemeral nature of digital images in the age of mobile media.

This paper will look at the recent development of the democratization of image making and sharing through the use of mobile media, such as Twitter, Instagram and Youtube. I will briefly look at the history, and aesthetic implications of using indeterminacy and real-time systems in both the arts and sciences. I will then outline some of the aesthetic issues explored in my most recent generative art I call CRUFT, which are created using source images downloaded from the vast database of mobile media now on the Internet.

This code based art resulting in CRUFT is important because it brings into question our assumptions about the use of indeterminacy in the creative process, as well as the materiality and ephemeral nature of the aesthetic experience.

Placebo Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/placebo/

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[2] Norbert Wiener, "*The Human Use of Human Beings Cybernetics and Society*", Da Capo Press, 1950

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Keywords:
Systems aesthetics, cybernetics, indeterminism, mobile media,

CRUFT: Recent Explorations in Indeterminacy, Materiality and the Ephemeral in the Age of Mobile Media

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Abstract

CRUFT are images created by automated computer scripts that first download source material from the Internet, and then process this information, generating new art work 24 hours a day, 7 days a week. Beginning in 2003, early versions generated CRUFT images from the digital leftovers of the main stream media news sites using indeterminacy, genetic algorithms and the use of feedback systems. Recent work has explored the ephemeral nature of digital images in the age of mobile media.

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1. CRUFT: Generative Art From Digital Leftovers

In 2003 the main stream media's portrayal of the United States going to war in Iraq was presented as an inevitable event, which caused me to feel much frustration and anxiety. As the media ramped up it's war campaign, the anti-war effort seemed to dissipate over night. As the 24/7 cable news continued, I began to think about how these digital images operated, one day influencing our thinking, and the next day they would vanish without a trace. I set out to create art on a cable news cycle. I wrote computer code that I could automate, that would remix source images downloaded from the Internet, and would process these images into a digital collage. The digital leftovers reminded me of redundant computer code. Code that was once useful, but later forgotten and obsolete. The code is described in Wikipedia as follows:

> Cruft (occasionally kruft) is computing jargon for "code, data, or software of poor quality". The term may also refer to debris that accumulates on computer equipment. It has been generalized to mean any accumulation of obsolete, redundant, irrelevant, or unnecessary information, especially code. An alternative usage is becoming more generalized to refer to any unneeded or unwanted computer hardware or obsolete equipment. [1]

The very first automated script I wrote, using source images from the New York Times website, is called *Hourly Cruft* and has been running and producing new images every hour on the hour since June of 2003. [2] I will now briefly look at the history, and aesthetic implications of using indeterminacy and real-time systems in both the arts and sciences, before I discuss the recent development of the democratization of image making through the use of social media.

2. Programmability, Indeterminacy and Systems Aesthetics

Although the printing press in the fourteenth century and photography in the nineteenth century had a large impact on the development of modern culture, the printing press affected only the distribution of media, and photography affected only that of still images. As Lev Manovich states in *The Language of New Media*, "The computer media revolution affects all stages of communication, including acquisition, manipulation, storage, and distribution; it also affects all types of media – texts, still images, moving images, sound and spatial constructions. [3] He goes on to discuss the immediate impact that photography had on society, which I will talk about later in this paper. Manovich makes the argument that the development of media and the development of computers begin around the same time. He describes in some detail the first programmable loom:

> Around 1800, J. M. Jacquard invented a loom that was automatically controlled by punched paper cards. The loom was used to weave intricate figurative images, including Jacquard's portrait. This specialized graphics computer, so to speak, inspired Charles Babbage in his work on the Analytical Engine, a general computer for numerical calculations.... Thus a programmed machine was already synthesizing images even before it was put to processing numbers." [4]

The power of automation, as demonstrated by Jacquard's loom, is shown to predate that of photography by almost 30 years. If we now jump to the mid-twentieth century, we will see the beginnings of the scientific discipline of cybernetics, which emerged out of attempts to regulate the flow of information in feedback loops, to predict, control and automate the behavior of machines and animals. Although cybernetics was a collaboration of many, Norbert Wiener coined the word itself, as he states, "Cybernetics, which I derived from the Greek word *kubernetes*, or 'steersman,' the same Greek word from which we eventually derive our word 'governor.'" [5] Cybernetics offered an explanation of behavior within mechanical and biological systems in terms of the exchange of information. Wiener offered the following description:

> When the great control rooms at the locks of the Panama Canal are in use, they are two-way message centers. Not only do messages go out controlling the motion of the tow locomotives, the opening and closing of the sluices, and the opening and closing of the gates; but the control room is full of telltales which indicate not merely that the locomotives, the sluices, and the gates have received their orders, but that they have in fact effectively carried out these orders.... This principle in control applies not merely to the Panama locks, but to states, armies, and individual human beings.... This matter of social feedback is of very great sociological and anthropological interest. [6]

Information in a cybernetic system is transferred dynamically and with the use of feedback, that information informs all parts of the system, enabling the whole to self-regulate in order to maintain a state of equilibrium. Wiener also suggests that cybernetics can be applied to more than just industrial systems, but also to social, cultural and biological systems as well.

I now want to turn to Jack Burnham, who in 1968 published the book *Beyond Modern Sculpture*, which attempted to establish a post-formalist discourse which culminated in the exhibition *Software* at the Jewish Museum in New York in 1970. This exhibition contained many examples of Systems Art, which was influenced by cybernetics and emerged as part of the early conceptual art movement of the 1960's and 1970's. [7]

In *Systems Aesthetics* Burnham sketches out a broad paradigm shift within late modern society that is no longer oriented towards material objects, but towards modes of organisational efficiency and utility. The idea of art for Burnham is reconfigured as “a perspectivist considering goals, boundary, structure, input, output, and related activity inside and outside the system. Where the object almost always has a fixed shape and boundaries, the consistency of a system may be altered in time and space, its behavior determined both by external conditions and its mechanisms of control.” [8] Although his art criticism has fallen out of favor, the impact of his work was limited, partially because of his technological determinism. According to Edward Shanken, the *Software* exhibition failed for numerous reasons:

> The DEC PDP-8 Time Share Computer that controlled many of the works did not function for the first month of the exhibition due to problems with, ironically enough, the software. The gerbils in SEEK attacked each other, a film was destroyed by its editors, and several aspects of the exhibition - including the catalog - were censored by the Board of Trustees of the museum. The show went greatly over budget which put the Jewish Museum in a precarious position financially. The Jewish Theological Seminary bailed it out, but dictated a radical shift in the museum's mission, which precipitated Karl Katz’s dismissal as its director and its demise as a leading exhibition space for experimental art. [9]

Burnham's reputation was surely damaged due to this exhibition, as well as him tying the notion of art as a system to a particular type of conceptual art of the late 1960's and early 1970's. He thus gave his systems aesthetics the same short lifespan of certain kinds of conceptual art.

3. From Atoms to Bits, Aura and the Internet

Today most of us carry a mobile device that connects us to the Internet, allowing us to express ourselves in real time by creating words and images as well as distributing them to a global audience. At the leading edge of the 21st century, more people take more photographs than any other time in history. This is creativity on a vast democratic scale never before seen. The computational device that we carry in our pockets and still call a “phone,” gives us the abilities of what twenty years ago required a traditional television studio or the resources of a newspaper publisher, to accomplish. The barrier to entry comes at a low financial and technical cost, allowing practically anyone to capture and edit still and moving images on a mobile device and instantly publishing and distributing creative content to the world. There is no previous socio-economic model to allow so much creativity, by so many people, changing the populations role from media consumers to media producers. It is important to realize that this global network is a gigantic copy machine. To publish to the Internet is to make a copy, and to view content on the Internet, is to make a copy. I want to look at the effects photography has had on our creativity, from the ability to index reality through optical and electronic devices, to the act of capturing moments in time by documenting the present, to the process of creating completely computational photorealistic realities using only software.

Let's look back to the first known examples of media making. A recent discovery dates the earliest cave paintings to be at least 40,000 years old. [10] So old in fact, that archaeologists wonder if a Neanderthal painted them. The images were a form of hand stencils, where a hand was placed against the cave wall, and then pigment was spit or blown onto it. When the hand was removed, a negative imprint remained. Since the time of those first paintings on a cave wall we have had the urge to leave a trace of our presence by making images that document that we existed, and that we had ephemeral hopes, dreams, and fears. These were our original shadows that we left behind on the cave wall.

For most of the past forty millennia artists have made traces with such materials as charcoal and paint, developing observation and technical skills as well as the conventions to represent the illusion of three dimensional space on a two dimensional surface. Optical devices were invented, such as the camera obscura which projected an image of it's surroundings on a flat surface. It was used for drawing and was one of the inventions that led to the development of photography and the camera. The first permanent photograph was captured by Joseph Nicephore Niepce in 1826, using a petroleum derivative called bitumen of Judea to capture light.[11] As the technology improved, indexing reality through a lens led to an existential crisis, calling into question the role of art and the artist.

Jump to the 20th Century, where much of the art of the time largely rejected the goal of illusionistic representations. The creation of illusionism was delegated to optical and electronic devices capturing images of reality in photography, film and video.

Illusionistic representation has become the domain of mass culture and media arts. What became our reality, was a particular linear perspective and depth of field, certain tonal and color ranges, as well as motion blur, which was ultimately created due to the limitations of the camera itself. The camera's representation became our reality, it was not realism but photorealism.

In Walter Benjamin's 1936 essay entitled 'The Work of Art in the Age of Mechanical Reproduction', he discusses a shift in perception and its affects after the advent of film and photography. He writes of the loss of aura through the mechanical reproduction of art. For Benjamin the aura represents originality and authenticity. A painting has an aura while a photograph does not. He states “Even the most perfect reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be.” [12] The destruction of the aura due to mechanical reproduction signals the transition from artwork as a ritual object, to artwork as exhibited in a museum. The experience of mechanically reproduced images, no matter how perfectly copied, is a missing sense of presence. It is the presence of the object that is it's aura. Benjamin then goes on to say, “Mankind, which in Homer’s time was an object of contemplation for the Olympian gods, is now one for itself. Its self-alienation has reached such a degree that it can experience its own destruction as aesthetic pleasure of the first order. This is the situation of politics which Fascism is rendering aesthetic. Communism responds by politicizing art.” [13] The attempt of fascism to render politics aesthetic can be seen in propaganda such as Hitler's mass rallies and ultimately in war, as expressed by the Italian futurist F. T. Marinetti, and most recently by the self-destructive aesthetic pleasure one feels watching reality television, and 24 hour, cable news.

In the 20th century art made a transition from an artifact of ritual value to an object on display in a museum. Today we have transitioned from an image as a physical object made up of atoms, to one that is now only software made up of bits. Our visual culture is photographic in its appearance, and generally digital in its form. It is important to realize that all digital photographs as well as all digital information is not just media, but also computer data.

Social media such as Facebook, Twitter and YouTube have us documenting our lives with photos, videos, time lines, and status updates. The time between living an event and documenting an event has collapsed. We live life in a constant state of the present compressed into a soon to be past. If Walter Benjamin's aura is destroyed with mechanical reproduction, sharing a photo on Instagram allows the present moment to be documented as an immediate past event. Adding an Instagram preset, such as a sepia filter makes images look like they are made of atoms with a history and a physicality. This computationally created nostalgia simulates a one of a kind art object that may have been sitting in a shoe box for the past thirty years.

Most photography today never enters the world of atoms, and is nothing more than computer bits existing nowhere and everywhere, displayed upon screens and stored on hard drives separated by large geographic distance. In the age of digital images which can be manipulated algorithmically, the separation between production and post-production has completely blurred. Even our digital cameras perform computational compression at the moment of image capture. With the acquisition of Instagram, Facebook is the world's largest photo sharing site that also happens to be a social network. Instagram users upload 3,480 photos [14] and YouTube users upload 72 hours of new video every minute. [15] We use screens to look into this copy machine, and consume and produce it's content, atoms have been replaced by bits. As photographers and media makers, we are still adjusting and making sense of this instant documentation and distribution with an art practice that produces bits.

The Internet helps make these digital media objects ephemeral, ubiquitous, easily copied and freely available. Information wants to freely flow everywhere on the network. Unlike traditional art objects, there is no inherent scarcity on the Internet as information gets copied time and again, traveling over fiber optic cables, moving information at literally the speed of light.

Digital technology and this giant copy machine we call the Internet, mirrors our own evolution as a species, and has given humanity a Twittering voice and Instagram eyes to see and change the world. [16]

4. Recent CRUFT: Reparation for Events Real and Imagined

As I have recently considered Norbert Wiener's 'Cybernetics' as well as the 'Systems Aesthetic's of Jack Burnham, I have become interested in thinking about the Internet as a large real-time database being updated every minute by thousands of mobile media files. This system of input, output and feedback that is really one big copy machine, with each of our hardware devices such as laptop computers, tablets and mobile devices being nothing but a screen looking into the copy machine that is so often referred to as the cloud. These devices allow us to touch this machine and to add our content to the database, sharing our files with anyone in the world who is connected.

As an artist, I want to use these mobile media files as source material. My recent series is building a fictional narrative which I call “Reparation for Events Real and Imagined.” I access this source material by automated scripts that search through the interface of Yahoo! Images. I am appropriating these images from the Internet, allowing algorithms to make the selections.

In a similar way Marcel Duchamp set the conceptual framework with his Dada gesture to select everyday objects as art, which he called Ready-mades. My algorithms select with aesthetic disinterest, much the way Duchamp described his own process:

> “A certain state of affairs that I am particularly anxious to clarify, is that the choice of these Ready-mades was never dictated by any aesthetic delectation. Such choice was always based on a reflection of visual indifference. And at the same time total absence of good taste.” [17]

My search results are then processed using a similar disinterest, made possible by using a process of indeterminacy, the images are then processed with techniques that render the new media objects to take on a similar appearance to certain social media websites such as Instagram. An algorithm processes the image to look like an old polaroid, holga photo, or the effect of chemical emulsion with the texture of paper. These simulations point to an object made of bits, not atoms.

Anesthetic Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/anesthetic/

Anesthetic Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/anesthetic/

Phantom Limb Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/phantomlimb/

Phantom Limb Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/phantomlimb/

Placebo Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/placebo/

Placebo Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/placebo/

False Positive Cruft
(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/falsepositive/

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(Reparation for Events Real and Imagined)
http://www.robertspahr.com/work/falsepositive/

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Silvia Titotto | *Full Paper & Installation:* **Floating Transgenesis**

Abstract:
The paper presents the possibilities of creating transgenic species of artificial life that take shape inspired by a particular structure while up kinetically mimic others, allowing perception of the passages in time and throbbing, in structural terms, the relationship between the worlds exterior and interior of each one, and sharpening issues concerning the relationships between visual details of structures of the human body and nature.

This polidimensional aesthetic experimentation arises from a desire to build mutations in an installation artwork that has branched form in its initial configuration but it is constantly altered according to the following types of interactions: passersby, sound and climatic environment.

It is meant to work on transformations in space over time, while it is structurally concatenated by principles of growth, branching data for patterns present in the natural world outside (trees, corals, cracks, lightning, algae and metal formations inside gems) and the inner world (neurons, bronchi, alveoli, blood capilarese ramifications and denaturing protein).

What at first seems to be fragile and delicate rhythms of a mock up ends up driving force able to transform and recycle configuration initially found by the eyes of the visitor. A structure in a subtle ballet that unfolds in joyous elegance according to each new interaction.

Topic: Architecture

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Fractal, ballet, interaction, branches

Floating Transgenesis

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Introduction

My ongoing doctorate researches technological innovation on branching structures and how their growth patterns are somewhat related to fractal geometry. Mathematical algorithms seem to be limited to reproduce biological complexity, given by very broad needs the beings seek to meet, but mineral structures that have nothing to do with life also present quite similar branching patterns to those resulted from bio cell morphogenesis. Can one mix growth patterns from different structure origins in order to create artificial new life?

This essay presents some preliminary discussions about the possibilities of creating transgenic species of artificial life that take shape inspired by a particular structure while up kinetically mimic others, allowing perception of the passages in time and throbbing, in structural terms, the relationship between the worlds exterior and interior of each one, and sharpening issues concerning the relationships between visual details of structures of the human body and nature.

Case overview

This polidimensional aesthetic experimentation arises from a desire of build mutations in an installation artwork that has branched form in its initial configuration but it is constantly altered according to the following types of interactions: passersby, sound and climatic environment.

It is meant to work on transformations in space over time, while it is structurally concatenated by principles of growth, branching data for patterns present in the natural world outside (trees, corals, cracks, lightning, algae and metal formations inside gems) and the inner world (neurons, bronchi, alveoli, blood capilarese ramifications and denaturing protein).

What at first seems to be fragile and delicate rhythms of a mock up ends up driving force able to transform and recycle configuration initially found by the eyes of the visitor. A structure in a subtle ballet that unfolds in joyous elegance according to each new interaction.

Brief State-of-the-Art

The work keeps aesthetic and mechanical relationships with some work already carried out, in particular: a pair of architects Ecologic Studio (fig. 1), engineer-artist Tomas Saraceno (fig. 2) and architect Philip Beesley (fig. 3).

Motivation

I started by visualizing some Sun rays that passed a few meters below the sea: above, that glare emulating a light at the end of the tunnel of water, and below, a colorful coral formation, intriguingly branched. In that tiny reef, the corals were not alone, they were instead part of a rich ecosystem with sea anemones, jellyfishes, colorful fishes, sea urchins and sea cucumbers, among a variety of other species.

After dwelling long journeys on the subject theory, I was willing to understand through the effective work of my own hands the movement of some of these incredible beings who, carrying in their structure traces of their growth patterns, they instigate my eyes in order to understand the potential applications of those principles in a new way of designing architectural spaces, perhaps... although mainly working on a pure installation artwork experimental field.

Processes and Procedures

During a workshop ministered by Professor Anthony Viscardi the attendees were advised to make posters on selected categories as part of the methodology in order to understand biomechanics. I separated image references into three classes: the fixed branching structures, the ones prone to very limited movement, and those that can move more freely. From those classes on,as I was seeking to draw a line of reasoning about the growth patterns of structures, I ended up refining them into sub-categories: two and three-dimensional branching biological structures and architectural spaces that took advantage of the concept of fractal repetition.

Inspired by studies of marine geometry modeled hyperbolically in crochet by the biologist Margaret Wertheim and her artist twin sister Christine, I started with anemones models, in particular those species that move according to tides, in reference to the real object that guarantees most of its drive due to the movement of other fluid, salty water (movements structured by thin elastic cables passing inside the straws).

Then, corals, because I was thinking of enriching my artificial “marine environment” of the experimental installation in coexistence of the initial model with new models of other species. I made diagonal cuts and inserted other straws in these incisions. There soon became a 'forest' or a reef of corals.

Instead of a set of models in symphony, I sought to develop adaptations to the real ones, as if they were ornamental coral or architecturally bionic. I tried several notches in such settings that could allude to the Fibonacci series. But I ended up preferring my little beings free to move according to the imaginary tides and the nutrients available in the medium.

Resuming studies intuitive joints, I tested other materials like beads and perforated plastic balls of various diameters. And to structure them, strips of cedar wood, which did not fit their robustness of the proposed red corals, which seemed to dance slowly to the rhythm of the waves echoed in the marine space.

I concluded that the medical materials could serve the purpose of searching for translucency and extensive range of thicknesses. I prepared a few preliminary tests with rubber casing colorful morbid structure, but medical silicone tubes were used in plastic tubes and trachea which have partially account of my questions and the final solution to structure the spaces was found by assembling the model using transparent carbon fiber.

I exhaustively reproduced this process in all small corals, so that they could have visually resulted in toys with projections of moving shadows and under water inside a transparent acrylic box: a micro-world, submerged, reasonably free, moving at the mercy of the waves and impromptu tides simulated by me, after all, an ephemeral sound designed to paradoxically bring along the silence of the sea.

The mutable arrays of branched structures in nature and in the body, in the imagination of the visitor, slowly ceases its motion at some magical moment passing imperceptibly into the field of pictures.

After this phase, in order to achieve these poetic goals, the work started hosting an interdisciplinary technical support, for example by inserting robotic structure with empty channels whose interior contains installing electrical cables that respond to sensors, adding the dimension of a complex design.

Acknowledgments

I acknowledge Professor Anthony Viscardi for his kind support during the workskhop, besides Professors Clice Mazzilli and Carlo Ostorero who have being advising this research across the ocean. I am also very grateful to USP Pos-Graduation Rector that made possible the exhibition of this experiment in Lucca, besides CAPES/Brazil and EMEWC/European Union for financing the author's research.

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Floating Transgenesis

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"Floating Transgenesis (FT)" is a mutant zoomorphic structure designed and prototyped by the author. The coauthor has aided in the fields of robotics programming and currently testing interactions from the input given by internet interface users in real time.

The poetic experiment exhibited in GA2012 is "transgenically" structured by the union of the branched morphological structures of one or more species with the kinetic possibilities of other biological beings that could add up broader complexity movements. In this essay some of the concepts involved in the creative process and building procedures such as their biomechanics properties, the ecologically chosen materials and the synesthetic experiences are summed up as follows:

Shape: "Artificial biomes" spatially disposed in an helicoidal configuration set
Number of elements: 8 sets of tarantulas, totalling 50 groups, 8 vertical centipedes, 3 aeroponic cultivated poppies accompanying vertically passersby and 6 denaturing protein.

- Twenty-five groups run on translucent material under impression of floating in the air. The reason for this is that the artificial "biomes" will be attached to the ceiling and the floor by steel cables thin enough to withstand its own weight and the electronics that power the robotic answers.
- There is a possibility of making a few extra anchors between the artificial "biomes", walls and stairs, because this results in thinner cables and enhance the impression of floating in the air.
- Double mirror is settled on the floor and up on the ceiling so that infinite branching images are generated virtually.

Related Elements
Poetic abstraction formed from the union of morphological elements of a species with the kinetics of another species.
*Tarantula: element represented by synthetic coral branches that emulate movements of a spider.
*Protein: geometric shape of a protein that has wobbly movements.
*Centipede: element represented by the body of a centipede and movements of their feet in wavy shapes.

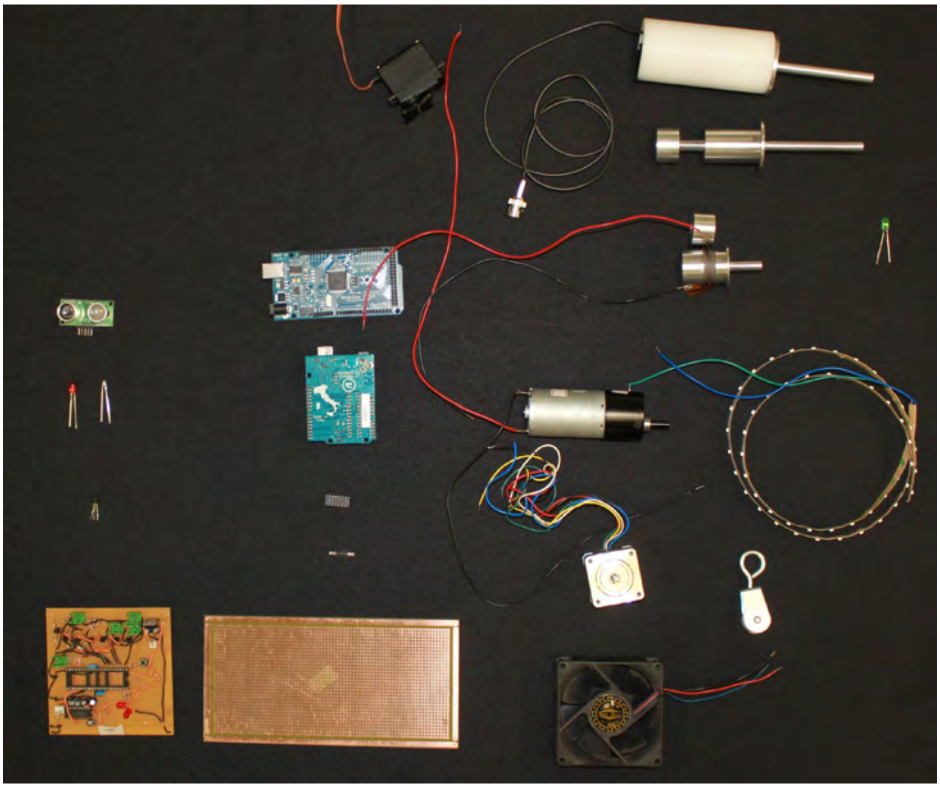
Movements and Synaesthesia

1. Use of muscle wire and memory alloy to soften and naturalize robotic movements in an intervention that aims to respond directly to the subtleties of human presence.
2. Elbow rotation of each grouping of cut pieces made of EFTE (Ethylene

tetrafluoroethylene, a fluorine based plastic) in branched structure, governed by servo motors activated by motion sensors.

3. Flexion of elbow-attached arm groups according to the intensity and speed of visitor approach.
4. LED light explosion from the inside out in a particular biome when the electrical circuit is closed by activating sensors presence when four visitors approach the biome in the same niche.

5. Activation of nature sounds in the environment through approximation of a given "device-biome" and available for re-start of another sound only after the first is finished, avoiding conflicts and sound pollution.
6. Lifting and stabilizing of vessel aeroponic poppy cultivation (absorption of water by ultrasonic spray that water roots).



Materials for construction of the main structure of objects

- ETFE and acrylic waste: to be used in prototypes and initial study of space. Characteristics of ETFE: density: 1.20. very low crystallinity, thermoplastic, clear, colourless. Remarkable properties of ETFE: resemblance to glass, highly resistant to impact, good dimensional stability, good electrical properties, good resistance to flow under load and weatherproof, flame resistant.
- PET Bottles: colourless and transparent: Use of the thread, use of the nozzle and use of the min body for structural and water reflection/refraction experiments by LED.
- Steel cable.
- Medical silicone tubes.

Synaesthesia

- Aroma: smell of forest emitted by ultrasonic spray.
- Touch: perception of materials that invite touch such as silicone, latex and ETFE.
- Color: predominantly transparent and translucent, except of course by chlorophyll green poppy and very fine silvery steel cable.
- Sound: The sound is triggered by occupancy sensors that are in the steel cable at the base of each object, thus beginning a song that recalls the context of biomes, starting another just after the end of the first.
- Movement: The movement is also done by triggering presence sensors, thereby initiating the movements of joints, turns and shakes. These reactions combined the essence of movement present in some structures found in nature result in transgenic mergers.
- Lighting: The lighting is demonstrated in every element of a particular form expressing their peculiarities.

* Tarantula: Together with their pleadings movements LEDs are driven at their ends accentuating the perception of motion.
* Protein: Driven by a vibration that causes the effect of tremor, with its lighting synchronizes the movements reflected in its structure, showing the configuration changes that occur in their primary, secondary, tertiary and quaternary developments.
* Centipede: Unlike the other elements of the proposal, its light effect is reversed and it

occurs from the inside out. It also triggered in sync with her movements and lighting refers to the rhythms of movement that can be performed by a backbone.

Interface between "Human - Machine - Space"

HMI interface is the communication channel between human and automated mechanical system that enables the interaction between them.

In other words, it is the part of the automated system that the person comes into physical, perceptual and conceptual contact.

The sensors are used to detect the presence of the user interface through human - machine space - and actuators are used to respond to stimuli from the sensors.

The various system sensors identify what is happening in the environment and feed this information to the microcontroller. The project elected the following sensors:

- Sonar: inspired by nature, such as bats, this system aids in navigation and detection of movements. The basic principle of operation is the emission and reception of ultrasonic (high frequency mechanical waves) which propagate into the environment. When there is a barrier, these waves are reflected and captured by the receiver. Thus it is possible to detect the presence of people in the environment and also its distance to the system, for example.
- Infrared Sensor: An invisible light to humans is emitted by a transmitter and sensor captured by another sensor, called receptor. If this beam of light is interrupted due to the presence of a person, for example, a signal is generated.
- Although infrared is invisible to humans, this is a principle used by some animals, including a rattlesnake that can see light in the infrared range and uses this ability to detect their prey.
- Temperature sensor: LM35 will be used sensors manufactured by National Semiconductor Corporation with the objective of verifying the temperature variation in the system.

From data input sensors, the microcontroller interprets the data and defines what action should be taken. The microprocessor design was chosen for the Arduin Mega 1280 due to the size of available memory, ease of handling, programming platform free and also low cost.

Finally, this information is sent to the output triggers that perform specific tasks to allow movements and system responses. Motors, servo-mechanisms, LEDs, ultrasonic actuators and coolers like those used in personal computers were elected as starters, targeting the experimental kinetic-sensory effects described earlier in this essay.

The ongoing experimental research is testing an Internet Programming Interface so that internet users are allowed to interact in real time with the installation, broadening the kinds of interaction proposed so far: climate, presence and noise. FT might need to come back to the next GA2013 for a visit in order to keeping up with news on the experiment.

Acknowledgments

The prototype was also gifted with technical advice from the mechanical engineers David Julio Costa, Victor Tayra and Bruno Chaves, ongoing doctoral researchers of the department of Mechatronics of University of Sao Paulo, who are acknowledged for their kind support. I am also very grateful to USP Pos-Graduation Rector that made possible the exhibition of this experiment in Lucca, besides CAPES/Brazil and EMEWC/European Union for financing the author's research.

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Simon Schofield

Paper: An approach to creating very large, high resolution artistic printed images

Topic: Visual Arts

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Abstract:
Contemporary printing processes, such as wall and floor graphics, offer artists the potential to create very large-scale pieces. However creating images that exploit both the potential size (say many metres square) AND resolution of the media (say 200 dpi), is very difficult using standard bitmap editing software as both the creative processes involved and file sizes become too cumbersome to manage. We present an approach to this problem that uses a combination of algorithmic techniques to control the generation of such an image as a set of non-repeating, seamlessly tiled sections, and facilitate a high degree of artistic authorship throughout the process. Our approach also necessitates the use of generative techniques, primarily in generating a very high degree of local detail over the entire surface of the image. We also hypothesise a further generative technique for building potentially limitless images at high resolutions. A working example is given.

Image of Generated Artwork

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Keywords:
Artworks, Print, resolution, generative texture, bitmap manipulation

An approach to creating very large, high resolution artistic printed images

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Abstract
Contemporary printing processes, such as wall and floor graphics, offer artists the potential to create very large-scale pieces. However creating images that exploit both the potential size (say many metres square) AND resolution of the media (say 200 dpi), is very difficult using standard bitmap editing software as both the creative processes involved and file sizes become too cumbersome to manage. We present an approach to this problem that uses a combination of algorithmic techniques to control the generation of such an image as a set of non-repeating, seamlessly tiled sections, and facilitate a high degree of artistic authorship throughout the process. Our approach also necessitates the use of generative techniques, primarily in generating a very high degree of local detail over the entire surface of the image. We also hypothesise a further generative technique for building potentially limitless images at high resolutions. A working example is given.

Introduction
Increasingly accessible large-format printing processes, such as those producing billboard size wall and floor graphics, offer artists the potential for creating large scale artworks. Such systems use standard ink-jet technology and so enjoy the potential capability of printing at near-photographic resolutions (300 dots per inch or greater). However it is highly unusual that such high resolutions are used in the production of billboard size graphics. The traditionally held view is that such high resolutions would be squandered at a billboard's intended viewing distance of, say, 10 meters. Also, sourcing and manipulating the enormous digital image file necessary to provide such a high degree of resolution over such a large expanse creates a number of problems that we discuss.

In most extant cases, billboard sized prints use a resolution only adequate for distant viewing (say 4000 pixels by 2300 pixels, over 6 x 4 meters, viewed at 10 meters) with a resultant print density equivalent of around 17 dots per inch (dpi). This low-resolution printing strategy suffices for the purpose of exterior billboards and hoardings. However, it is not really an option if we consider producing images for the floors or walls of a domestic setting, or an art gallery. Looking down on a floor graphic at a typical viewing distance of 1.5 meters, a normally sighted person can resolve detail of up to around 100 dpi [1] (see footnote 1). In a domestic setting, a wall graphic might be inspected as if it were a painting, perhaps from a distance of 0.75 meters, where a higher resolution of 200 dpi might suffice. At this higher resolution, if the floor or wall image were 6 meters by 3 meters, this would require an overall digital image size of 48,000 by 24,000 pixels (1,150 Mega Pixels); what we refer to, for convenience, as a "massive image".

While a 1150 MP image can be theoretically declared in memory (Photoshop currently potentially allows users to declare an image 300k pixels x 300k pixels, a 9000 MP image [2]), an image of such size would be extremely cumbersome to manipulate within current interactive environments such as Photoshop or Gimp [3]. File loading, manipulations, redraws and save times become frustratingly slow under such conditions. Worse still if one starts to build up a number of layers to manipulate the content of the image (as is standard practice in most image editing software), as each layer adds further demands to the memory. Under such duress, both software and hardware may also become unreliable, and this coupled with the overall slowness of response makes for an untenable situation.

The next problem posed by massive images is in sourcing the desired image data. Clearly there are extant processes that can *mechanically* provide the image-matter to fill the space of such massive images. A single continuous photographic scene can be assembled from a set of abutting photographs such as Google Maps [4]. There are many other large composite images, such as the current record holder, a 272 Giga Pixel image of Shanghai [5] (See "The Largest Photographs in the World" page of Wikipedia [6]) that could be used to populate a highly detailed continuous printed images of this sort of scale. Many visual artists, however, seek to create quite arbitrary images, such as digital murals, designs, paintings or complex montages where high degrees of visual creativity and arbitrary intervention come in to play over all parts of the image. They wish to work freely gathering imagery from many disparate sources, and so have only limited need of this sort of mechanically produced content.

Another methodology to create high levels of detail over a large physical expanse is to use the step-repeat method of wall paper; while this allows for a high degree of creativity over the single repeat pattern, there is no scope for variation over the image as a whole.

Without recourse to repeating sections, or using mechanically harvested imagery, the artist is left to apply the detail over every part of the image as if "by hand", so that any section can be viewed close up and provide visual engagement. Such an undertaking via standard image editing techniques would be oppressively laborious over such a large surface.

Forbearing of the above, once the piece has been fully composed, it must be printed out as a series of partially overlapping or abutting *print-tiles* (or "pages" as they are sometimes referred to in the print trade), each generated from a separate print file. These print-tiles are then physically re-assembled into the whole image on-site.

We present an approach for creating extremely large non-repeating murals that addresses many of these technical and creative problems. The output image from our approach is arbitrarily large; both logically and physically, highly detailed over every part of the surface, and contains no discernible repeat patterns. Our approach also affords a good degree of artistic control and visual feedback during the production process. Our technique makes necessary and good use of generative techniques, primarily in redressing the image-detail problem, and speculatively in generating images of potentially limitless size.

We present an actual example of our system at work, generating an image of 54,000 x 12,000 pixels for a printed piece 18 meters by 4 meters at 100 dpi. We also hypothesize that our approach enables the production of almost limitlessly large printed surfaces, where every part of the printed surface can be unique.

Method

In our approach, the memory problems of massive images are mitigated through generating the full-scale imagery only during the production of the final printed output, one print-tile at a time, and therefore, one print-*file* at a time. Each print-file is of a known and manageable size; the larger the overall image, the more print-files are generated. As the system only needs to cope with one print file at a time it is the in-memory size of an individual print-file, rather than the overall image, which is the limiting factor. Consequently, in our system, the full size image never actually exists in memory in its entirety.

The overall design, composition and user-interaction for the whole image all takes place in a drastically reduced, small-scale "key" image assembled and manipulated by the artist in a standard layer-based image editing system, such as Photoshop. The completed design, held in the key-image, is composed from a number of layers, each layer containing a single layer-patch of "image matter". Each layer-patch of the key-image has a smallish bounding box in relation to the overall key-image size (see Fig. 2), and each layer-patch corresponds, by its layer name, to a much larger version of the layer stored as a distinct "full scale patch" file in a local directory. The layer-patches, both small and full-scale, contain alpha to determine transparency, and give them visual irregularity. The layer-patch positions, relative drawing order and layer names stored in the key image are made available to a specially developed scriptable image-compositing engine through the use of Python/COM [7]. Using this data, the image-compositing engine is able to produce a full-scale render of a specified print tile. For each print tile, the engine inspects the layers occupying that section of the key-image (see Fig. 2). The system then creates a print file, using the full-scale patches, based on their relative positions within the key-image to create a "flattened" image using Porter-Duff [8] alpha compositing. Each print file is saved out in turn.

The compositing engine operates by giving access to a set of low level image handling functions (such as load, save, image transforms, filters, and compositing functions) through Lua script [9], and is used both the full scale rendering and, as described later, in the rendering of synthetic textures. Lua sessions can be saved and loaded, making for a convenient and flexible image processing system.

This technique of working small, and rendering big, through the use of small scale "image-proxies" has been utilised as a core methodology in previous systems such as HSC Software's *Live Picture* [10] although the technique has somewhat fallen from common usage today, presumably because systems such as Photoshop suffice in most practical cases.

In our actual example given below, the completed key-image was composed of around 100 layers (Figure 1). However, we found that we could use duplicate layers several times within the overall image without the duplication becoming visually obvious, as the layers visually intermingled in different ways. This reduced the number of different full-scale patches required to around only 25.

Once this process pipeline has been established, it is easy to view and control the overall composition of the image, and edit and make new patches as required. So, while the final rendering process is script-driven and mechanistic, the process whereby the overall image is constructed and manipulated enjoys most of the interactivity of a Photoshop session. Indeed, the process provides a very fluid method for working from sketch to final version, so long as the artist maintains the relationship between the small layer-patches in the key-image, and their full-scale counterparts.

Fig 1. The overall key-image, composed from around 100 layers

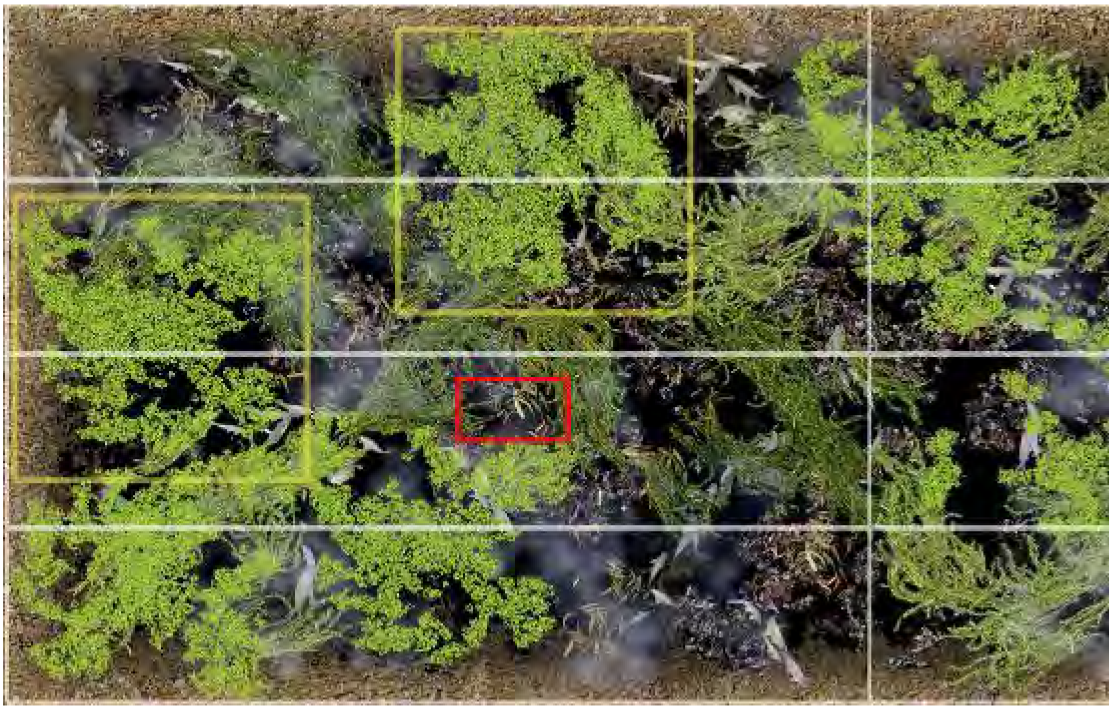

Fig 2. The surface broken into print tiles (defined by the white lines), with two "layer-patches" of duckweed highlighted in yellow. The full-scale render of the region within the red box is shown in Fig 3.

Fig 3. Indicating the level of detail at all points of the final image

Generating Detail

Apart from managing the large size of the overall image and providing a good degree of interactive authorship dealt with so far, our process also hinges on being able to generate a large variety of full-scale image patches containing extremely high levels of detail (from which are derived their small scale layers in the key-image). In our working example we use three techniques for generating the full-scale patches; natural photography, standard compositing, and a generative technique for texture synthesis.

In the example image, the pebbles and Elodea pondweed (the long flowing weed) were obtained by straightforward photography and given alpha masks by standard matting techniques. The patches of Fish were created originally from natural photographs, but then cut out and arranged into fluid shoal-like compositions using standard image editing software.

The patches of Duckweed and Junk (Figures 4 and 5) were synthetic textures generated using the scriptable image processing engine. The basic process was to generate a detailed final texture (output image) from the repeated compositing of smaller elements (input images) according to a set of stochastic functions. The input images, in the case of the duckweed patches, is a set around 20 alpha-masked Duckweed leaves stored as alpha-masked PNG files. The system builds a list of these input images, selects one at random, scales and rotates the image within bounds, and attempts to place it onto the output image at a random point. A larger mask-image imposes an overall distribution of the duckweed, and is responsible for the overall shape of the patch. The final output rafts of duckweed were constructed using something in the region of 5000 iterations. A "junk carpet" was generated using around 100 individually photographed, and alpha-masked differing pieces of junk, and can be seen laying at the bottom of the pond in the final image.

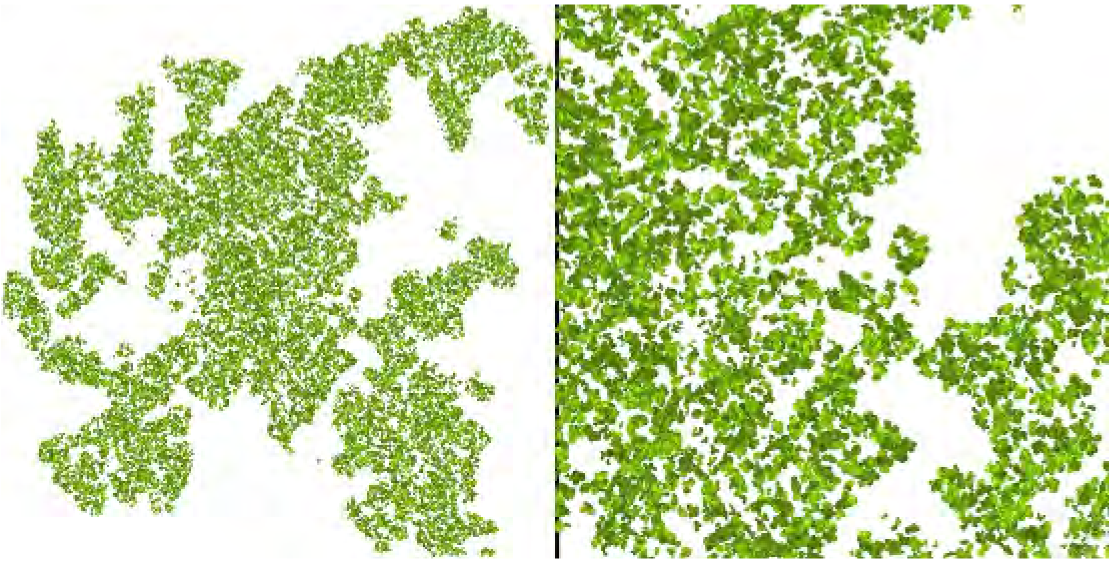

Fig 4. A generative texture: Duckweed patch and detail

Fig 5. A generative texture: The "junk carpet" patch and detail

This method of texture synthesis, where textures are generated through the repeated addition of "patches" of image, is generally known as "Texture Bombing" and has several precedents, notably the work of Paul

Haeberli [11] in creating painterly surfaces, and owes something to Xu *et al* [12] patch-based texture synthesis and Efros and Freeman's [13] Image quilting. It is most similar to Dischler's [14] Texture Particles, but in our context is not intended for 3-D texture mapping, and used in a purely 2-D sense.

Results – A working Example

The techniques described were used to create a floor-based artwork (*The Kipple Pond*) originally commissioned by a UK Museum and shown in October 2009 and re-commissioned by a New York Museum in April 2010 (details withheld to maintain anonymity). The first version was 18 meters by 4 meters, and produced at a print resolution of 100 dpi, using Scotchprint 2000 Floor Graphic, in 12 sections. The NY version was 12 meters by 3 meters, in six sections using Scotchprint Pavement Graphics.

Upon encountering the piece, visitors were able to walk across the surface of a large and highly detailed millpond. At first glance the image seemed to be a huge natural photograph of a real pond, full of weeds, insects and fish. On closer inspection, the undulating bed of the millpond was seen to be composed of an accretion of thousands of items of man-made detritus or "kipple" as P.K. Dick called it [15]; jewels, coins, toys, tin cans, electrical components, bottles, screws, cutlery, pieces of machines and so on; the natural and the unnatural existing in close visual harmony, suggesting that nature might have a restorative effect over man's promiscuous outpourings. The resultant effect was poised between a single *Trompe-l'oeil* image, expansive decorative surface and a visual puzzle.

Fig 6. The artwork in situ in the UK 2009

Fig 7. The artwork under the harshest of scrutiny

Conclusions and Future work

Our creative methodology works well as an expressive medium for the artist by allowing the creation of an infinite variety of fully detailed, non-repeating, large-scale artworks. The process enjoys a good degree of fluid interactivity and visual feedback, and is reasonably amenable to continual edits and updates to content. There are, of course, repeats of elements at certain levels within the image; the duckweed leaves repeat at the small scale, and the large patches may be used several times each within the overall image. But at every level the repeat is concealed. The large image patches all intermingle in different ways, making each part of the surface unique, and the viewer is unconcerned about repeated elements (such as the Duckweed leaves) at the lowest level of detail.

Because the actual "final" image is never realised as a whole within the computer's memory, but rendered and saved out as uniformly sized print-ready files (each one a manageable size for most computers/printers) the potential size of the complete output image is unlimited. Indeed, one could imagine a system where the key-image is replaced, functionally, by an algorithm generating the necessary descriptions of patches to render a print-tile (and its abutting neighbours) out of an arbitrarily large surface. Such a system would potentially be able to churn out limitlessly big images. One would however have to ensure that the algorithm produced something suitably varied and interesting over the actual extents of the final image, and this may not be a trivial undertaking. Indeed such an algorithm might in turn rely on a worked up key-image to generate a statistical model of the distribution of elements. Such a system would go some way towards the notion of generating endless, non-repeating surface designs that might be used instead of traditional wallpaper or floor covering.

A "deep zoom" version of I *Kipple Pond* can be found online at www.simonschofield.net, along with other generative artworks.

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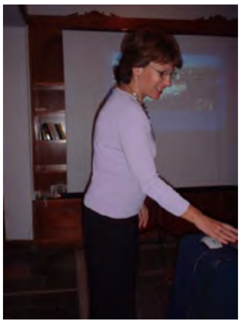
Footnote

To calculate the size of the smallest object that can be perceived at a distance of 1.5m: The smallest angle subtended by a 'normal' eye is 1 minute of arc (or 0.01667 degrees). This calculates an object of around 0.25 per mm, the visual equivalent of around 100 dpi.

Sonja Nikolic

Paper: **GENERATIVE ART OF NATURE - MOLECULES**



Topic: Chemistry

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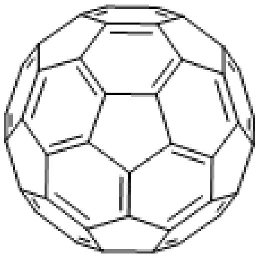
Abstract:
Chemistry is a science of making molecules and studying their structures, properties and reactions. One of the central concept in chemistry is the concept of molecular structure and one of the central problems in chemistry is the deduction of molecular properties from the structure of the molecule.

We can look at the molecular structure in a variety of ways. The simplest view of the molecular structure is the molecular composition. This is the number and kind of atoms making up the molecule. This representation is a kind of one dimensional molecular structure. Next in the hierarchy of structure of the molecules is the molecular constitution. This is a kind of two dimensional representation of molecular structure. It contains the bonding relations between atoms in the molecule.

In this lecture we shall be concerned with the symmetry characteristics of geometric structure of molecules. The molecules are essence of human lives and surrounding. It seems that the Nature has its own generative approach for making molecules with the targeted purpose, but it is still a secret to the human being, although the science discovered many of the rules of the Nature.



Buckminsterfullerene, C60

Fullerene C60 resembles to soccerball

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Keywords:
Chemistry, molecules, structure of molecule, molecular composition, molecular constitution

Stanislav Roudavski	*Paper:* **Expanding Architectural Materiality through Dynamic Continuous Differentiation** *Artwork:* **Freeze-Volume Perceptions: Seeing Dynamic Architectural Systems through Static 3D Prints**
Topic: Architecture ***Authors:*** ***Stanislav Roudavski*** University of Melbourne Department of Architecture ***Gwyllim Jahn*** University of Melbourne Department of Architecture ***references:*** Lynn, Greg (1999). *Animate Form* (New York: Princeton Architectural Press) Schumacher, Patrik (2011). *The Autopoiesis of Architecture: A New Framework for Architecture* (Chichester: Wiley)	This paper discusses design challenges and potentials of hybrid physical/digital architectural environments. In this context, the notion of continuous differentiation (cf. Lynn, 1998, pp. 8-43; Schumacher, 2011) - inspired by natural environments and enabled by computation - is taken as an illustrative challenge to architectural creativity. Existing work discusses and implements continuous differentiation as a static outcome of underlying processes. This paper expands this concept by discussing differentiation that sustains continuity through time as well as through space. Dynamic material effects made possible by this approach include variable porosity, ornamentation, lighting and surface articulation. The paper's central research question asks whether architectural materiality can be expanded through this approach. To trigger critical reflection on the developing nature of architectural materiality, the paper analyses the outcomes of a particular experiment that implemented parametric geometry, interactive environment and a high-density responsive agent system in an architectural installation. The paper argues that its case-study demonstrates unique compositional potentials and contributes a productive concept for further critical discussion, experimentation and research. Artwork: This project consists of static and moving images describing complex agent systems and their individual states in virtual and physical environments. The systems at the centre of the project's narratives explore topographically-situated complex behaviours. The behavioural history singular moments is represented as a continuously differentiated meshes. These meshes are then used to create 3D prints. Resulting physical models act as perceptual frames that help to examine architectural-design potentials of particular system states. Used in parallel with other ways to visualise complex systems, this approach can usefully contribute to architectural design. Thus, static 3D-printed models can reveal unobvious architectural phenomena among dynamic emergent patterns generated by populations of agents. For instance, parallel traces left by groups of agents can materialise as surfaces, overlapping paths can become repeating apertures and collisions be read as volumes. In addition, tactile 3D-models can reveal spatial characteristics of complex dynamic systems that are perceptually inaccessible through two-dimensional screen renderings. For instance, depths, curvatures, volumes, focal planes and other characteristics essential in architectural composition can be perceived in 3D prints but are impeded on-screen. The proposed art project contributes to the creative discourse by demonstrating visual evidence that critically examines the implications of freeze-volume perceptions to thinking about complex systems in architecture and beyond.
Contact: ***stanislav.roudavski@cantab.net***	***Keywords:*** architectural design, agent systems, continuous differentiation, generative design, interactive architecture

Emergent Materiality through an Embedded Multi-Agent System

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Abstract

The paper discusses the implementation of a multi-agent system as an integral component of a hybrid, digital-physical architectural environment. It contributes to the existing practice-based architectural research in two ways: 1) by describing an innovative integration of a multi-agent system for surface patterning; and 2) by discussing this integration in terms of emergent materiality. This case-study demonstrates suggestive creative approaches and observes in the field the operation of a concept that promises to be useful for future analysis, research and design.

1. Introduction: material or immaterial?

Current discourse in architecture acknowledges the increasing importance of "immaterial" phenomena, such as exchanges of information [1, 2] and simultaneously emphasises the importance of materials [3–5]. Similarly, traditional ways of working, predicated by an understanding of architecture as hierarchical assemblies of objects with set material properties, are in conflict with the growing emphasis on processual architecture [cf. 6]. These contrasting understandings complicate the notion of architectural materiality and call for further practical and theoretical investigations of hybrid, physical/digital architectural environments.

Engaging with this challenge, this paper considers how the notion of continuous differentiation [7, p. 136] – inspired by natural environments and enabled by computation – can be dissociated from the form-, object-, and hierarchy-oriented notions of architectural composition. While Lynn does talk about "the composition of stable bodies that are capable of continuous transformation and mutation" (p. 137), much existing work discusses and implements continuous differentiation as static outcomes of underlying generative processes. These outcomes are said to be continuously differentiated when they exhibit gradual transitions between contrasting states [8, p. 141], where states are understood as physically material assemblies of objects. Thus, even when working with continuous differentiation, the compositional practice focuses on the constitution, description and valuation of architectural form.

This paper seeks to engage with parallel understandings emphasising processes, events and emergent characteristics by considering how differentiation occurs in time, as well as in space. Dynamic material effects made possible by this approach include variable porosity, ornamentation, lighting and surface articulation. They manifest themselves as events or performances rather than as static objects or forms. Extending existing discourses in this area [such as 9], the paper analyses the outcomes of a particular experiment that combined complex geometry with an interactive environment and a responsive multi-agent system in an architectural installation.

2. Assemblage: provisional formations of socio-technical actors

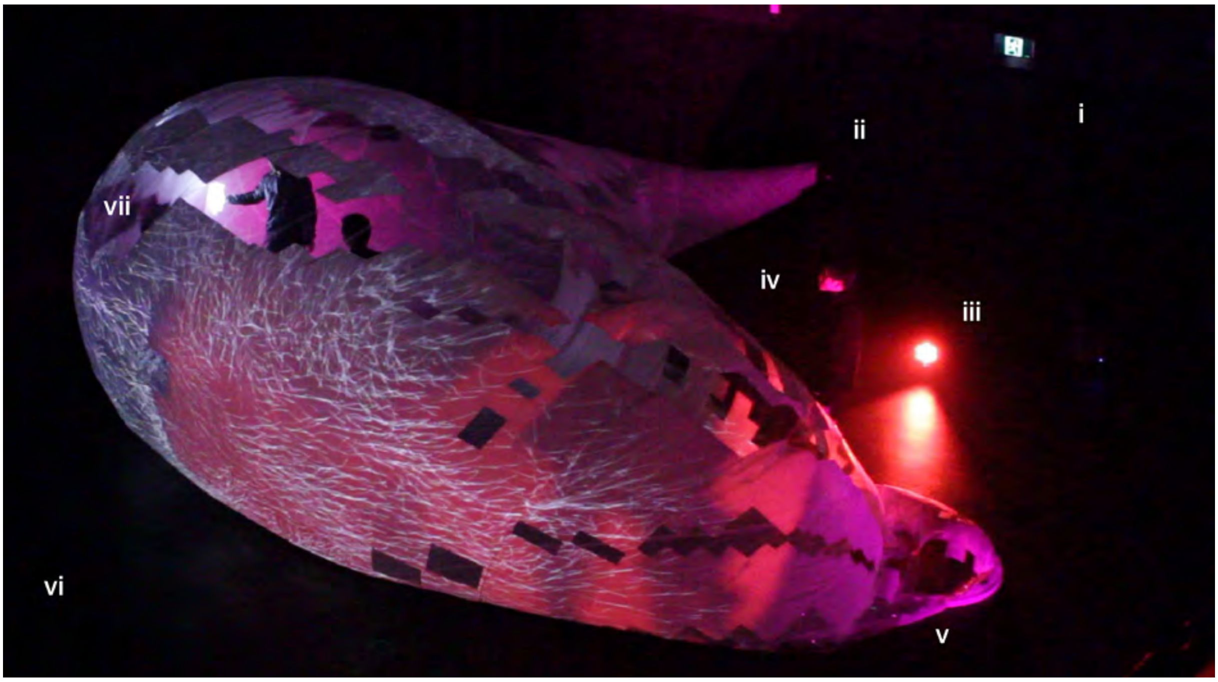

Fig. 1. Overview. i) perimeter speakers; ii) location of the fan; iii) one of the lights; iv) visitor, looking through the transparent patches; v) entrance to the inflatable; vi) towards entrance to the space and the projectors; vii) visitors carrying a lantern.

The Performative Architecture Installation discussed in this paper was designed and constructed at the University of Melbourne in 2011. It can be most productively considered as a temporary and continually regenerated open assembly of heterogeneous actors [10–13]. Within such an assembly, boundaries are unstable, fuzzy and dependant on the observers' capabilities and goals. However, the extended discussion of the overall assemblage is outside the scope of this paper. Instead, it focuses on one aspect – emergent materiality. Because this discussion of materiality would be inaccessible without a brief description of the overall system, it is provided in this section. To simplify this description, the paper identifies three formations: 1) a non-standard physical structure; 2) an interactive system; and 3) an emergent-behaviour system.

The physical structure of the installation is an organically shaped inflatable made from opaque and transparent patches. It was developed through multiple prototypes, following the principles of design through making [cf. 14] understood as "a discipline that can instigate rather than merely solve ideas" [15, p. 7]. On one hand, the parametric geometry of the structure was informed by parallel experimentation with fabrication. On the other, the form and the fabrication approaches were evaluated for their performance within the intended interactive setup.

The interactive system consists of video projectors; controllable lighting system; providing video streams for analysis of visitor behaviour; controllable speakers; light sensors; and a smoke machine. The control system was assembled in Cycling 74's visual programming software MAX running on a typical desktop PC computer. This setup enables incorporation of visitor behaviours into the overall performance and supports integration of generated effects with the physical structure and the surrounding space.

The focus of this paper is on the third formation, the emergent-behaviour system that was implemented using Processing/Java cross-communicating with MAX.

3. Emergent behaviour: a multi-agent system

The following two subsections discuss the multi-agent system employed in the installation as 1) a particular narrative structure able to produce dynamic, temporally differentiated and emergent material effects; and 2) as an embedded system that situates these effects in populated, messy and rich physical environments.

3.1. Narrative structure: agents, modes and emergent effects

Fig. 2. Narrative modes. Frames from a video showing an explosive transition from the Reflective mode (A) to the Agitated mode (B, C).

The narrative structure of the installation was developed through multiple iterations alongside its interactivity and physical structures. The primary organisational device here came not from static or moving images and not from the rules established within the programming environment but from micro narratives produced throughout the development process to capture desires, describe observed events and post-rationalise found effects. These mini-narratives (50–100 words) helped to establish temporary design criteria and supported communication between team members. Temporal in nature, they also actively encouraged thinking about continuing events instead of static snapshots of spaces or objects. No written narrative is possible within implicit (or actively developed) voice and thinking about narrators and alternative points of perception sharpened attention on the multiple co-existent foci of the interactive performance.

While design thinking benefitted from being periodically cast into the narrative form, the management of complex dynamic processes and integration of coherent and communicable design decisions through the creative team led to the chunking of the continuous interactive experience into narrative modes incorporated into a simulation of a spatial environment populated by agents.

3.1.1. Behaviour

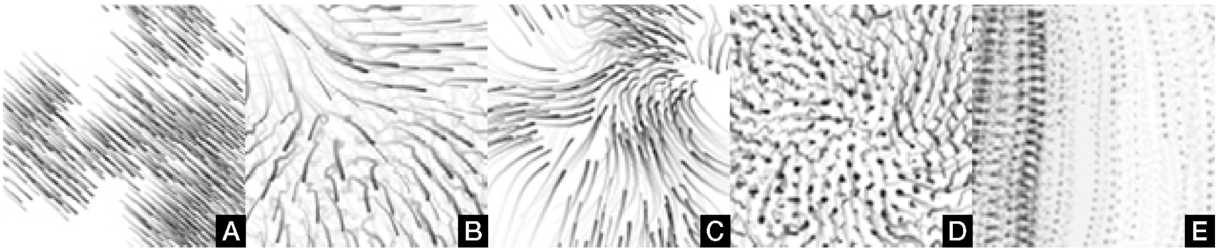

Fig. 3. Vocabulary of behaviours. Examples of emergent patterns.

This multi-agent system is operated by a basic software routine that initialises and iterates the simulation. The simulation takes form of a system composed of multiple interacting agents [cf. 16, p. 11]. Within such a system, an agent is "an entity that performs a specific activity in an environment of which it is aware and that can respond to changes." [17, p. 7]. However, the term agent is used in many heterogeneous ways, even in the artificial intelligence and artificial life communities where these ideas originated. Within Nwana's [18] typology, the installation's agents belong to the basic reactive type that acts "using a stimulus/response type of behaviour by responding to the present state of the environment in which they are embedded." (p. 209) The main characteristic of such agents is autonomy. They can perceive the environment they inhabit and act upon it. The functionality of the installation's agents was derived from the work of Reynolds [19] who defined his flocking "boids" as particles with predefined sets of behaviours allowing them to interact with other particles and their immediate environment.

The simulation behaviour of the multi-agent system is the hierarchical set of rules that defines interactions with other agents and with the environment. The Performative Architecture Installation's system adopts the basic assumptions of a Reynolds [19] flocking model: 1) each agent has an ability to perceive nearby agents; 2) each agent can perceive the whole world as a bounded dimensional space; and 3) all agents can recalculate their current state once per unit of time during the simulation.

The primary component of the internal state is the velocity vector but in extension of Reynolds, the Performative Architecture Installation's implementation stores additional data such as bin membership (see below) and previous location vectors for path rendering.

This basic implementation can be extended with rationality, ability to learn, more sophisticated internal world representation, etc. However even in its current specification, it exhibits performative characteristics that extend common possibilities of architectural materiality.

Behaviours. Agent behaviours are cumulative responses to rules. In the Performative Architecture Installation they take the form of two-dimensional movements. Rules are inaccessible to humans visiting the installation but behaviours are perceptible. Typical rules are static and global to all of the multi-agent system. In contrast, individual responses are dynamic and can be enlarged or decreased for individual agents.

Rules. Agents in the system adhere to two simple rules derived from Reynolds' boids algorithms: alignment and avoidance (Fig. 3, A, B). Each rule is conditional on the proximity of other agents and is effective for all agents within specified search radius and within the agent's grid cell. The algorithm operates as follows. For each neighbouring agent, find the distance between this agent and its neighbour. If this distance is less than the environment's threshold for a change in behaviour, modify the velocity of the agent such that the effect of the neighbour is inversely proportional to the distance between the two agents. To align two agents, the neighbours' velocity is added to that of the current agent. To avoid neighbours, the vector between the neighbour and the agent is found and added to the agent's velocity.

3.1.2. Environment

The environment that the agents occupy can include obstacles, field conditions such as wind and other phenomena. The Performative Architecture Installation implemented one environmental feature in the form of four attractors coincident with the sensor locations on the surface of the inflatable (for examples of local effects produced by these, see the project journal [20, pp. 130, 131]). In another example, an optimisation technique of spatial binning also became a perceivable feature of the environment (see, section 3.1.2.5 below).

3.1.2.1. Topology

The system's environment is a rectangular two dimensional space. It triggers both local and global changes in agent behaviours (e.g., see Fig. 6 for local changes and Fig. 4 for global changes). Local changes scale responses in relationship to specific coordinates, while global changes modify the installation's mode, affecting or substituting agents' rule sets. The environment constrains all possible agents' trajectories to two dimensions thus increasing the number of interactions between agents apparently moving in a three-dimensional space when projected on a curvilinear surface of the inflatable and thus increasing the likelihood and frequency of emergent effects (such as transitions, durations and patterns including clusters, waves, zones, grids and so on). In order to maintain the illusion of an unbounded and continuous space, topologically the environment is constrained to a sphere with agents' movement wrapping around the edges of the visible rectangle.

3.1.2.2. Modes

The system's narrative modes are (e.g., see Fig. 4):

> **Calm.** Very low intensity. The agents move with randomized low speeds and the avoidance is high. They form grid-like patterns, occasionally dispersing and reassembling. The overall effect is of quiet undulation and twinkling interrupted by brief periods of low activity that suggests potential for more dynamic behaviours (also, see Fig. 14).
>
> **Reflective.** Low intensity. Initially flocking in loose undulating clusters across the inflatable, the agents slowly blanket the fabric in a more uniformly dispersed pattern.

This state departs from the near-static equilibrium of the Calm state, but its alternating sub-states are still relatively passive (also, see Fig. 5 and Fig. 11).

Agitated. High intensity. Streams of agents race across the surface of the inflatable now and then exploding in bursts of energy (also, see Fig. 6).

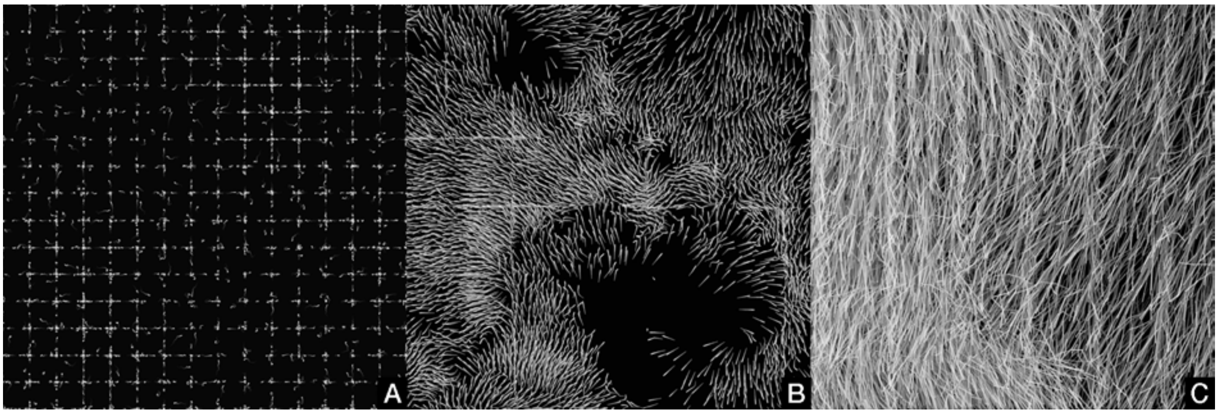

Fig. 4. Samples of modes: Calm (A); Reflective (B); and Agitated (C).

These modes were achieved through the alterations in positioning, movement and interactions between agents inhabiting a continuous field. Allen observes that in a field, “overall shape and extent are highly fluid and less important than the internal relationships of parts.” [21] His discussion of fields emphasised intervals, repetitions and seriality as primary characteristics.

When such approaches are used as metaphors or diagrams for interrelationships between objects (buildings, people, etc.), they can be productively employed as form-guiding strategies in the design process. When used in this way, they assume a utilitarian function in architects’ creative processes. The outcomes of such processes are typically static materialisations that do not openly expose their genesis or directly reflect the on-going renegotiation of spatial relationships (electronic, physical, chemical, etc.). In the Performative Architecture Installation, temporary but perceivable modes and change-vectors between modes, not objects or even relationships between them, act as primary phenomena. While these modes are pre-conceptualised and pre-specified by the designers, their behaviours are also constantly influenced by the surrounding dynamic environment. The forms of the field provide a commentary on the dynamic relationships of the site and can reconfigure these relationships by staging, framing, suggesting or discouraging particular social performances.

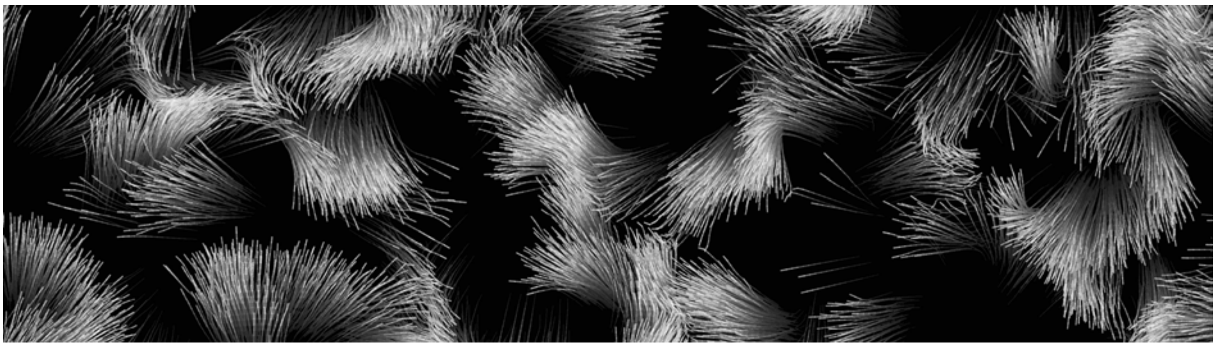

Fig. 5. Reflective mode. Chunking into brush strokes.

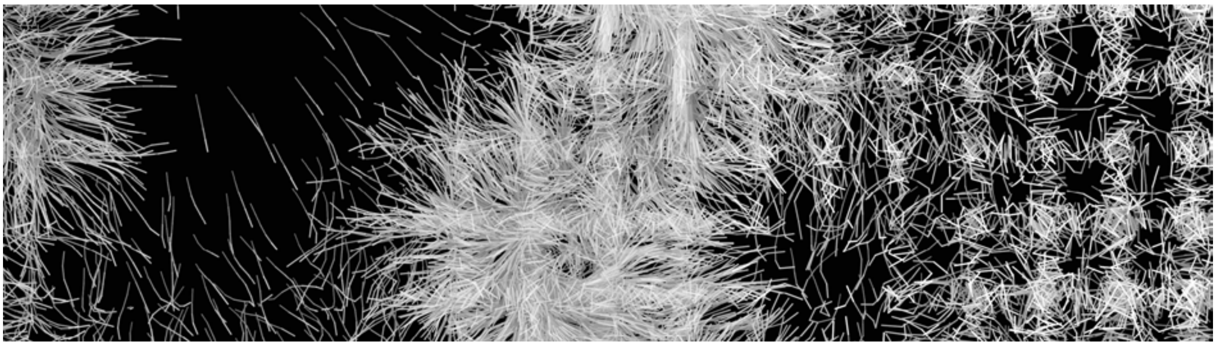

Fig. 6. Agitated mode. Visible gridding and local variations.

Technically, a mode is a predefined set of static and fluctuating parameters that scale individual behaviours of agents in a given environment. Because the parameters are quantifiable, it is possible to interpolate between and within modes to construct an infinitely differentiated parameter space.

3.1.2.3. Sub-Modes, Mode History

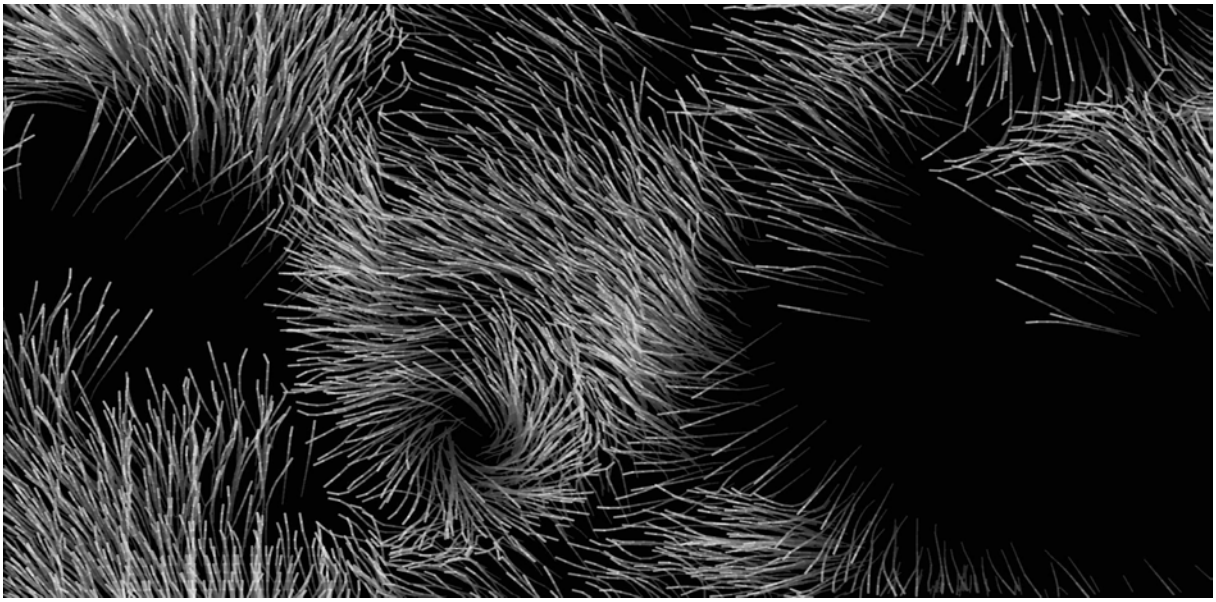

Fig. 7. Sub-mode transition. Dispersal of the chunked brush strokes into a uniformly spread field, mid-transition. Mode: Reflective.

As the environment is only capable of maintaining a single mode at any one time, each mode operates with an embedded memory of previous modes and of their duration. This memory effects the selection of parameters within the subsequent mode. Modes are capable of measuring parameter values, switching between parameter sets (sub-modes) and modifying or interpolating between parameter-set values over time (operating on mode history). Gradual changes in parameter values tend to produce perceptually smooth transitions between perceptible patterns. Such transitions can be slow, transforming the environment without advertising the change to the observers who, unless they pay special attention, can suddenly find themselves is a qualitatively different space (e.g., see transition from Fig. 5 to Fig. 7). Switching between sub-modes tends to rearrange the differentiated flow of patterns suddenly, so that the moment of transition is emphasised as a significant event (e.g., see transition from Fig. 9 to Fig. 6). The supply of various dramatic effects produced by sub-modes switching is incorporated into overarching emotional registers of the three principal modes. Sub-modes are distinguished by perceptible patterning and the rhythms of motion within constrained ranges of intensity representative of the parent mode. By contrast, the primary narrative modes are differentiated by the intensity of the behaviours they contain (see, e.g., Fig. 4).

3.1.2.4. Transitions

A transition is an externally triggered switch from one narrative mode to another (Fig. 4). There are six possible transitions: 1, 2) from Agitated to Calm or Reflective – capturing a slowly dissolving state of the last distribution produced by the Agitated mode; 3, 4) from Calm to Reflective and back – indicating the change with a heightened activity and then settling into a dispersed field; 5, 6) from Calm or Reflective to Agitated (Fig. 2 and Fig. 14) – resulting in an explosive change, with agents rapidly moving away from their initial positions, supported by dramatic lighting fluctuations and highly active audioscape. Transitions are triggered by the sensors or a computer vision system using camera-stream analyses. Both trigger types react to the visitors' behaviours. Through these triggering mechanisms, the multi-agent system becomes a participant in an open assembly that can accept events, energies and deliberate behaviours from external participants.

During a transition, the current mode with its last distribution of agents acts as an input for the subsequent mode. Hence, the character of the transition is a product of the reorganisation of agents within the environment (Fig. 8 and Fig. 14). Transitions result in a range of effects not exhibited within modes and produced by the contrasts in agent behaviours and speeds (or, to put it differently, redistributions of energy). Both transitions and sub-modes act to introduce order (or concentrated energy) in the environment by establishing gradients in the behaviour and distribution of agents and affecting the system's entropy. Gradients here are understood as energy-story phenomena, such as uneven distributions of energy in molecular systems with intensive properties (temperature, pressure, density). [e.g., cf. 22, p. 9] (Fig. 8, B, C, D) For example, some modes compress agents into smaller regions in the environment, resulting in explosive redistributions during a transition to a subsequent mode (Fig. 8, C, D and Fig. 14, B, C). Others narrow the range of search, resulting in perceptually random movement because with fewer agents found, repeated interactions between pairs occur infrequently. This change produces contrasting readings of agents' intensities and groupings (Fig. 8, A, C). Another example of a transition effect is produced when active well-defined clusters of agents of the Agitated mode become frozen as perceptually static (but slowly dissipating) partially gridded patterns (Fig. 4, A and Fig. 14, A).

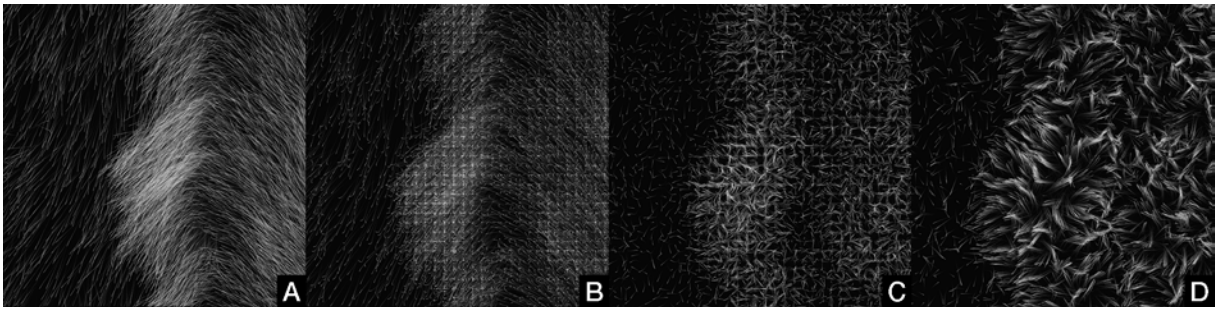

Fig. 8. Seeding. The current mode serves as a seed for the next. A, B: Agitated to Calm; C, D: Calm to Reflective.

3.1.2.5. Effects

As is evident from the above, the multi-agent system is capable of producing multiple emergent material effects. To illustrate, one such example is striation. The speed of each agent is limited to a global value. This value affects the proximity of pairs and controls the frequency of agent interaction. Consequently, high speeds tend to result in the emergence of striated patterns whereby agent velocities become averaged over the entire environment (e.g., see Fig. 9 and Fig. 8, A) By contrast, lower speeds produce more local variation through more frequent interaction between individuals (e.g., see Fig. 4, B and Fig. 8, D).

Fig. 9. Striation patterns in the Agitated mode.

Another example of an emergent effect is gridding. In this case, it is a consciously permitted visible artefact of optimization. Larger populations produce more complex and nuanced effects. The environment becomes more diverse and agents interact not only as individuals but also as groups. However, the time needed for a sequential search algorithm to update all agents increases proportionally with the population size, quickly depleting performance capabilities of a typical computer and undermining the real-time performance of the system. And some form of proximity searcher is necessary to drive behaviours. In order to increase the population size of the simulation, the system implements a simple spatial binning algorithm. The environment is partitioned into lists or ‘bins’ arranged as a Cartesian grid. These bins are populated by agents based on their current positions. If the next location of an agent corresponds to a different grid cell, it is removed from its current bin and added to a new one. Any subsequent proximity searches are constrained to the agents within the current bin, greatly reducing the running time of the algorithm.

In addition to accelerating the computation, and in contrast to common practice that minimises behavioural artefacts produced by the bin grids, the Performative Architecture

Installation deliberately employs it for the production of visible grids when their appearance is justified by the overarching narrative. The emergent effect of grid lines and squares is used to establish scale, emphasize curvature, strengthen the effects of perspective foreshortening and create contrasting patterning that precedes or follows fluid motion.

These effects emerge when parameters cause agents to avoid other agents within a range that is larger than the dimensions of the bins. Such conditions make grid edges visible because agents oscillate between neighbouring cells (Fig. 11 and elsewhere). The linearity of the grid contrasts with the fluid geometry of the agent paths and patterns the curvilinear geometry of the installation as grid cells distort across its surface. Grid cells also act as sub-environments, compartmentalising agent interactions in a manner that results in cell-sized flocks. Within the global environment, these flocks emerge as painterly effects because small groups of agents become more legible than individuals or large-scale patterns (Fig. 5). Visible gridding of this type is a characteristic example of a found emergent effect. Originating from a simplistic implementation (such visible gridding can be easily eliminated if neighbouring bins are included into the search); this effect was adopted and curated for meaningful incorporation into the spectrum of available material expressions.

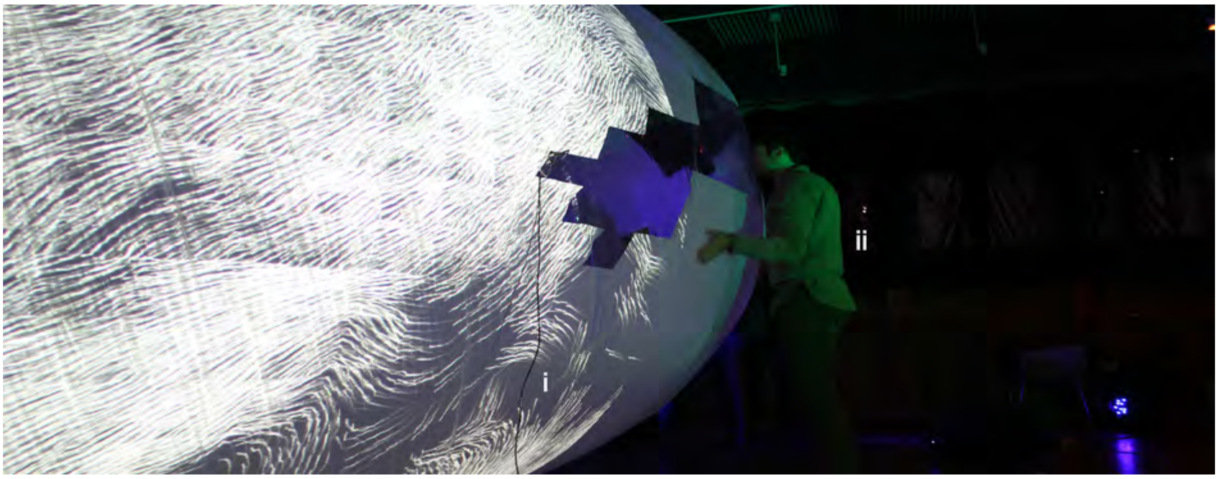

Fig. 10. Gridding 1. The patterns produced by binning, taken during design development. i) cable to the light sensor at the corner of the transparent patch, to be integrated into the skin; ii) looking and touching were encouraged.

The modes and the transitions between modes are defined in terms of bottom-up rather than top-down rules and relationships. Consequently, the resulting system always remains dynamic. Predictable at the macro scales, in terms of perceivable types of emergent effects referring to particular modes or sub-modes, the system never produces identical distributions at the level of interactions between agents and groups of agents.

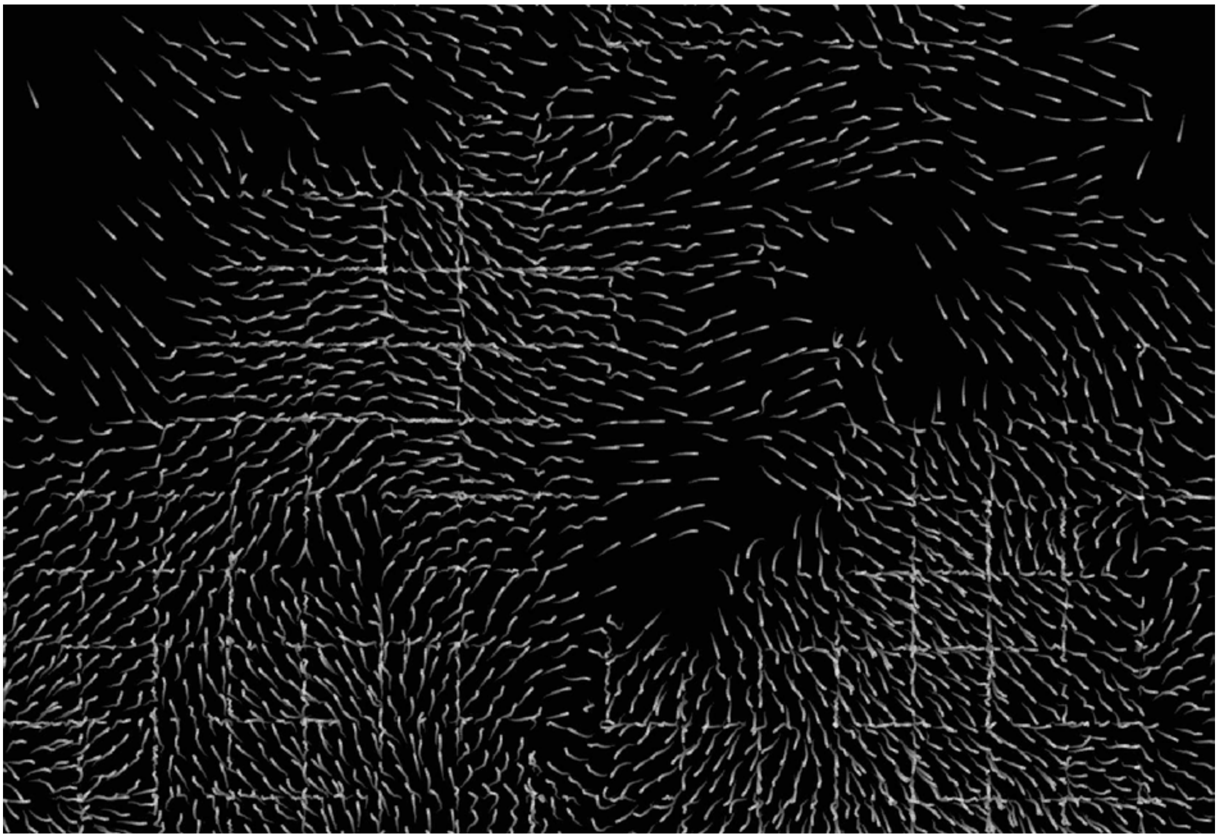

Fig. 11. Gridding 2. Appearance of the grid pattern in the Reflective mode.

3.2. Embodiment: agents in the charged space

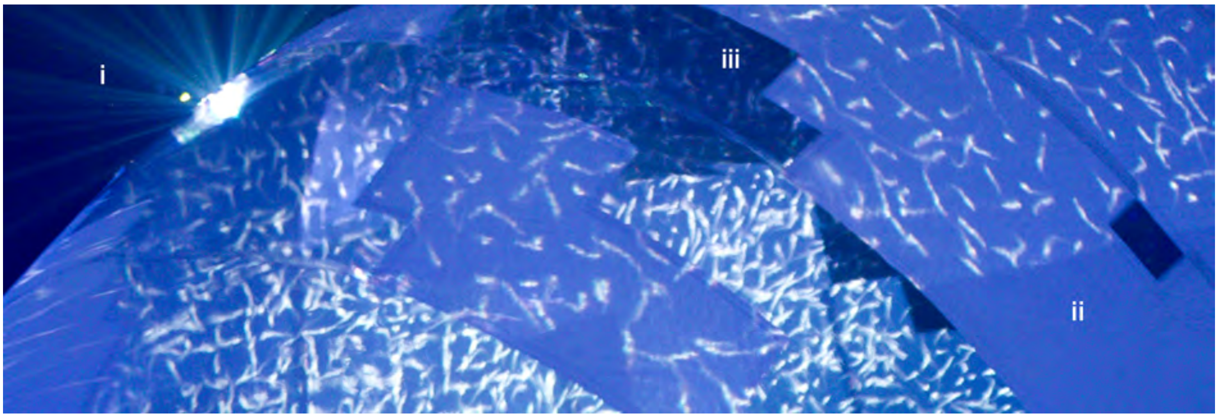

Fig. 12. Situated effects 1. The image shows volumetric light effects (i); differences in scale and sharpness; shadows (ii); and effects on the transparent areas.

In the case of the Performative Architecture Installation, the terminology of human-computer interfaces (graphic or otherwise) is too constraining. Instead, the installation can be more productively understood as a temporary and continually regenerated open assembly of heterogeneous actors. Morse [23, p. 167] describes settings hosting digital art installations as spaces charged with meaning. Visitors can traverse these spaces and the form of their itineraries constitutes an essential part of the poetics of an installation (see also the discussion of place construction in [24, e.g., p. 113]. Accordingly, the multi-agent system of the Performative Architecture Installation acquires additional and new meanings when incorporated into a situated performance. The installation's material characteristics then can be described as emergent not only because they are sustained by agent interactions but also because they become possible through enacted relationships with its hosting place, its visitors and so on.

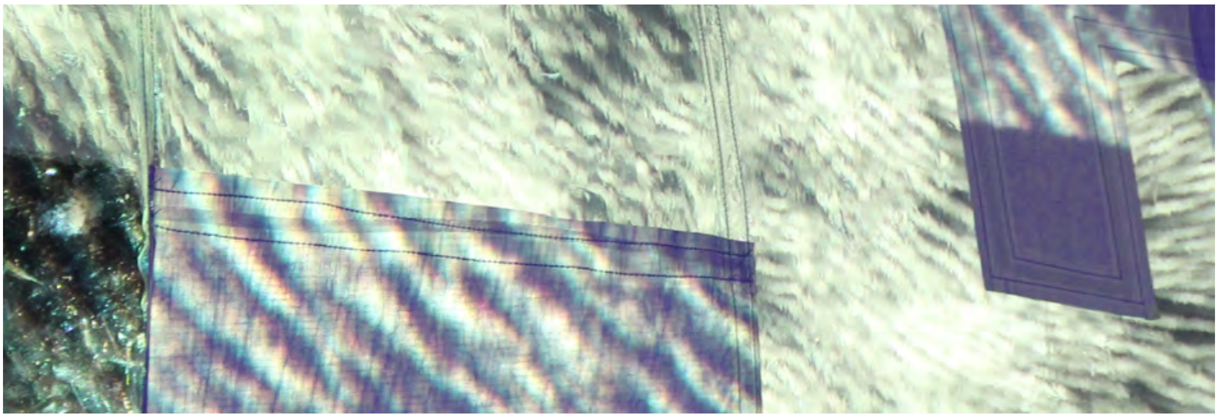

Fig. 13. Situated effects 2. Spectral effects; transparency and density; patterning and scaling.

As mentioned above, the man-machine interface included light sensors and video cameras as well as a dual video projection onto the complex shape of the inflatable structure. The transition from a computer screen to a curvilinear physical form generates effects that alter and enhance the expressive range of the agent system. The projection's integration with space, light, sound and visitors' bodies undermines the algorithmic certainties of computer code transposing it as one of many material presences into layered and much less orderly situated affordances and experiences.

Examples of such situated effects include:

Surface effects. Spectral effects: at points of foreshortening or scaling (Fig. 13). Layering: the image penetrates the patches of transparent material to appear enlarged and blurred against the opposing inner wall of the inflatable (Fig. 12 and Fig. 13).

Point-of-view effects. Secondary images on people; through transparent patches; reflections; refractions; field-of-vision effects.

Light effects. Contrasting lighting modes supporting the narrative (Fig. 2); dynamic shadows and volume effects (Fig. 12). Effects by the stationary, computer controlled lights and from the lantern carried by the visitors (Fig. 14) (e.g., reflected light and glow).

Relational effects. Multiple layers of movement involving the installation and the visitors. Multiple layers of interaction between human and non-human participants. Parallel meanings constructed by multiple participants.

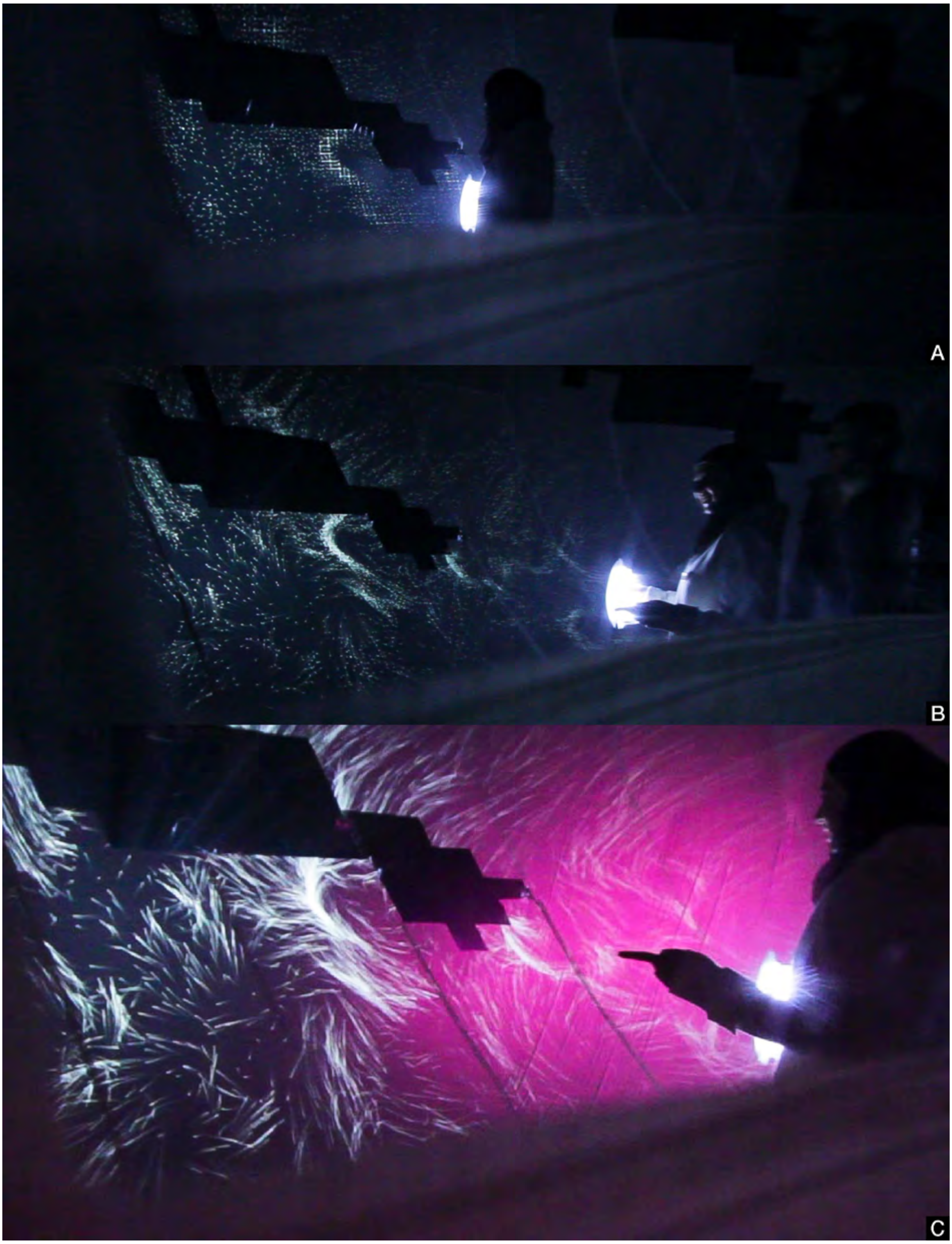

Fig. 14. Modes, lighting and atmosphere. A, B) Calm; C) Agitated.

4. Conclusion: towards emergent materiality

The examples of this paper discuss emergence as flows of matter and energy. While this emergence does not form static objects, its transient character does not prevent it from being real, material and accessible to human perception and experience. Consequently, this approach extends the current understanding of architectural materiality by providing examples of temporal continuous differentiation and emergent effects.

Primary characteristics of emergent materiality are not those described in relationship to objecthood. Instead they comprise "dimensionality, movement and duration" [25, p. v] or "intervals, repetitions and seriality" [21] as primary characteristics.

Ballard [25, p. 5] persuasively argues that "the digital machinic assemblage has specific affects and resonances that in some way distinguish it from previous (non-digital) assemblages." Machinic here refers to the mode of organization, not to the form of an object. Derived from Guattari [26, p. 39], and ultimately from Maturana and Varela [27], the term emphasises relationships between components that as (autopoietic) organisations are distinct from their materiality. The line of enquiry exploring controversial tensions between material and immaterial in architecture cannot be fully pursued in this paper (on my position in regard to their interrelationship in the case of virtual environments, see [28]). However the focus on enacted modes of organisation suggests a useful process-oriented conceptual and creative stance illuminated, for example, by Deleuze and Guattari's [10, p. 152] questions about a "body without organs": what does it do? what type it is? how is it fabricated? what are its modes? what comes to pass? what is expected and what is unexpected? with which variants and surprises?

As experienced during the practical work on the Performative Architecture Installation, the concept of emergent materiality [cf. 25, p. 172] is a good match to the designer's needs to think, talk and make architecture as on-going socio-technical performances rather than static and hierarchical compositions.

5. Acknowledgements and further information

The thinking and designing discussed above were collaborative. For further information and credits, see [20]. Additional images can be found here:

http://pas2011.tumblr.com/archive

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Tatsuo Unemi

Paper: **Synthesis of sound effects for generative animation**

Topic: Sound synthesis

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References:
[1] Tatsuo Unemi, "*SBArt4 as Automatic Art and Live Performance Tool*", GA 2011 – XIV Generative Art Conference, Rome, 2011.
[2] www.intlab.soka.ac.jp/~unemi/sbart/4/

Abstract:
As everyone knows, the sound effect and background music of motion picture is effective to emphasize what the author wanted to express. However, in case of fully automated generative animation, it is difficult to introduce such a method for design of accompanying sounds because the generator has no intention behind the process. This paper introduces a method to synthesize waveforms of sounds for an automated evolutionary animation [1, 2] by computer. To emphasize the emotional effects for viewers, it was designed as to fit the psychological effect of sounds with visuals under some intuitive correspondences between these two different modalities, such as a brighter image is associated with a higher pitch, a more complex texture inspires a noisier or more solid tone, and so on. The other mappings between statistical features of image and parameters of sound synthesis and modulation are also effective to produce richer audio outputs. In addition, the two types of restriction on pitches for the scale and on timing for the rhythm were also examined for automatic music composition. There are many potential applications and extensions from this research, including evolutionary production of sound effects, as future works.

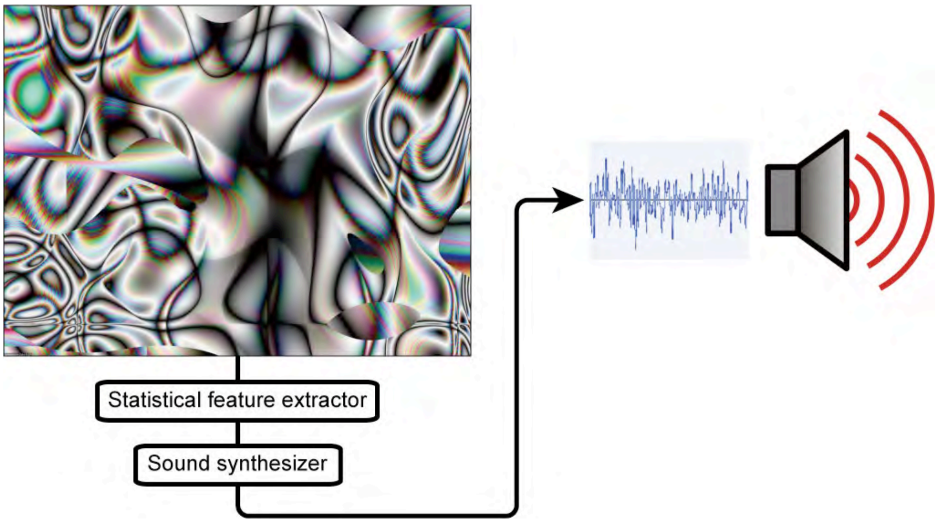

Illustration of sound synthesis from visuals.

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Keywords:
Sound synthesis, abstract animation, automatic art

Synthesis of Sound Effects for Generative Animation

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Premise

This paper introduces a method to synthesise sound effects from video images for an automated evolutionary animation. To emphasise the impression of visuals, it was designed as to fit the psychological effects of two different modalities under some intuitive relation between visual and audio stimuli. The other mappings from the statistical features of image to the parameters of sound are also effective to produce richer audio outputs even if there is no clear correlation between them. In addition, the two types of restriction on pitches for the scale and on timing for the rhythm were examined for automatic music composition. There are many potential applications and extensions from this research, including evolutionary production of sound effects, as future works.

1. Introduction

The sound effect and background music of motion picture is effective to emphasise what the author wanted to express. However, in case of fully automated generative animation, it is difficult to introduce such a method for design of accompanying sounds because there is no established method for automatic sound design. Furthermore the machine has no intention behind the process. This paper introduces our approach to synthesise sound waveforms of by the computer for an automated evolutionary animation [1, 2]. To emphasise the emotional effects for viewers, it was designed as to fit the psychological effect of sounds with visuals under some intuitive correspondences between these two different modalities, such as a brighter image is associated with a higher pitch, a more complex texture inspires a noisier or more solid tone, and so on. The other mappings between statistical features of image and parameters of sound synthesis are also effective to produce richer audio outputs.

In addition, the two types of restriction on pitches for the scale and on timing for the rhythm were examined for automatic music composition, which is expected to be enjoyable for audience from wider variation of backgrounds. The design of envelope, scale, harmony, and rhythm are important for music composition as same as timbre.

The sound design for motion picture has been a target of research for many years. The early works mentioned sound effects for film such as [3], but some of the recent works are relating to automatic sound synthesis from the simulation of physical entities, such as sounds of flowing water [4] and flames [5]. These approaches are to produce both sounds and visuals from a single computational model of physical objects, but not sound synthesis from visual data. Another approach to produce sounds from real-time motion visuals was examined by Dannenberg et al [6]. They proposed and implemented a system that synthesises sounds from video images of the waves on water surface in a small shallow container. Such an approach using fluctuation of natural phenomena is useful to produce a sound of natural flavour by an artificial system on the digital computer, avoiding a mechanical flavour. The technical requirement is almost same with ours, but the concept is facing almost the opposite orientation, because our installation is to build up another nature in the machine without any connection to the real nature.

The following sections describe intuitive relation between sounds and visuals, methods for synthesising waveforms, modulation, automatic music composition, and adjustable parameters by the user.

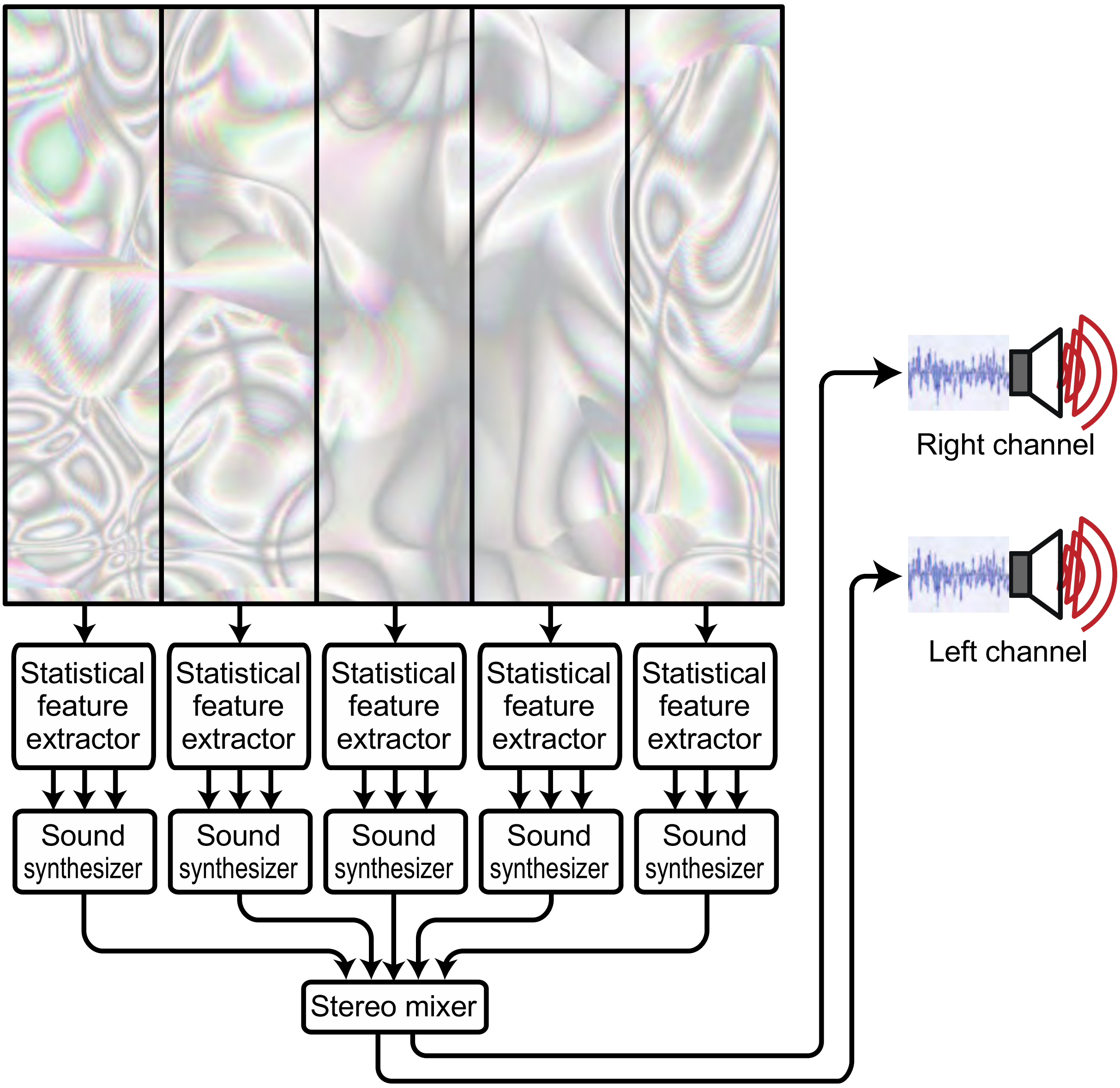

Figure 1. *Data flow of sound synthesis. A frame image is split into five sub-regions.*

2. Intuitive relation between sounds and visuals

Hearing senses by ears and visual senses by eyes are of course in different types of modality in human's sensation. However, it is also well known that people has an intuitive association between the stimuli of different modalities, such as brightness of both colour and sound. We can assume that the origin of these associations have been acquired from frequent experiences of physical phenomena commonly having happened among people. It causes both visible and audible signals for human at the same time, such as a sand storm that makes a scratchy image and a noisy sound. In the context of spatial perception, the positioning of a visible object in the personal view also has strong association with the positioning of sound it produces. For example, it is natural to position a sharp sound at the left audio channel when a bright light appears at the left side.

In this system, we implemented four features from this point of view; positioning of a multiple sound source, colour brightness and sound pitch, motion speed and loudness, and rough image and white noise.

2.1 Multiple sound sources

Multiple sound sources are a typical technique to make a richer sound. In the music, a solo play of a single instrument is interesting but an orchestra sound by tens of different types of instruments and players has large possible variations and can produce organised complex sounds of a high dynamic range in the audible sound frequencies. One problem to organize such a large scale of orchestration by the computer is the complexity from the large number of elements. It causes not only a problem of combinatorial organization but also of computational power to calculate them in real-time.

Because the number of sound sources should be restricted within a reasonable range to guarantee the sound synthesis is processed in real-time by a personal computer, we use at most eight sound sources that separately produce a sound for each. Each sound source corresponds to the sub-region of the frame image vertically split as shown in figure 1. The statistical features extracted from the image data in each sub-region are fed to the sound synthesizer. And then, those sound signals are mixed so that each one is positioned from left to right as same as the sub-regions are arranged, by adjusting the balance between stereo loudspeakers.

2.2 Brightness and pitch

The most effective feature of the melodic sound is the pitch. The system maps the average value of brightness over all pixels in the sub-region into the frequency of sound wave within the range from 110 Hz to 880 Hz. Therefore a brighter image makes a higher pitch, and a darker image makes lower pitch. This association is intuitively natural, but it sometimes results a cheap sound when the values of average brightness for all sub-regions are almost same. To guarantee the produced sound includes a wide dynamic range, we introduced a mechanism to add a variation of pitch ranges by shifting them in a proper number of octaves from the waveforms synthesized by the normal method. The lowest frequency is 55 Hz, and the highest frequency is 3.52 kHz. The highest pitch might seem still too low because human ears can hear the sound of higher than 15 kHz, but it is not a critical problem because a component of higher frequency is usually included in the basic waveform as described in later section 3.

2.3 Motion speed and loudness

When the image is changing fast, it looks hectic and presents strong stimuli since it provides dense information. A louder sound is suitable for such a case. If the motion is slow and calm, a monotonic sound of pianissimo seems to be appropriate. We implemented a calculation of average difference between brightness of two pixels in the same spatial position in the current frame and the image of weighted average over recent frames in order to compute the motion speed in visual frames. The brightness v_t of the pixel at the time t in the image of weighted average is revised in each step using an expression

$$v_t = \alpha \cdot b_{t-1} + (1-\alpha) \cdot v_{t-1} \tag{1}$$

where α is the weight constant of $0 < \alpha < 1$, b_t is the brightness of the pixel at the same position in the frame image in time t, and $v_0 = b_0$. The resulted value expressing the motion speed is also used to producing a synchronized rhythm for musical sound as described later in section 5.

2.4 Roughness and noise

A rough image, such as a ground surface with sands, associates noisy sound. To measure a degree of roughness, we calculate the average value of absolute differences of brightness among all of neighbouring pixels in a sub-region of the frame image. This value is mapped to the amplitude of white noise by adding a random numbers to each sound sample. To avoid this noise always happens, we introduce a threshold value of roughness. The random number is added only when the roughness is larger than the threshold value, and its value is multiplied by a coefficient that gradually increases from zero to one following the strength of roughness.

3. Synthesis of waveform

We introduced two types of methods to construct a basic waveform. The first one is to make a sequence of average brightness values of rows scanning from the top to the bottom of each sub-region in the frame image. The values are linearly normalized within a range [–1, 1]. The absolute value of samples in the top part is modified to gradually increase and the bottom part is modified to gradually decrease, so that the waveform can connect smoothly to the next phase of the waveform's repetition, as show in figure 2. The sharpness of the sound is adjusted using a type of low pass filter by calculating a moving average over the sequence of sample values.

Another method is to compound the harmonic overtones of which amplitudes are determined from the average brightness in sub-regions vertically divided as shown in figure 3. The number of harmonic overtones is 12 in the current implementation. In this method, the sharpness is adjustable by a decay coefficient γ ($0 < \gamma < 1$). The sample value s_t at time t is defined as

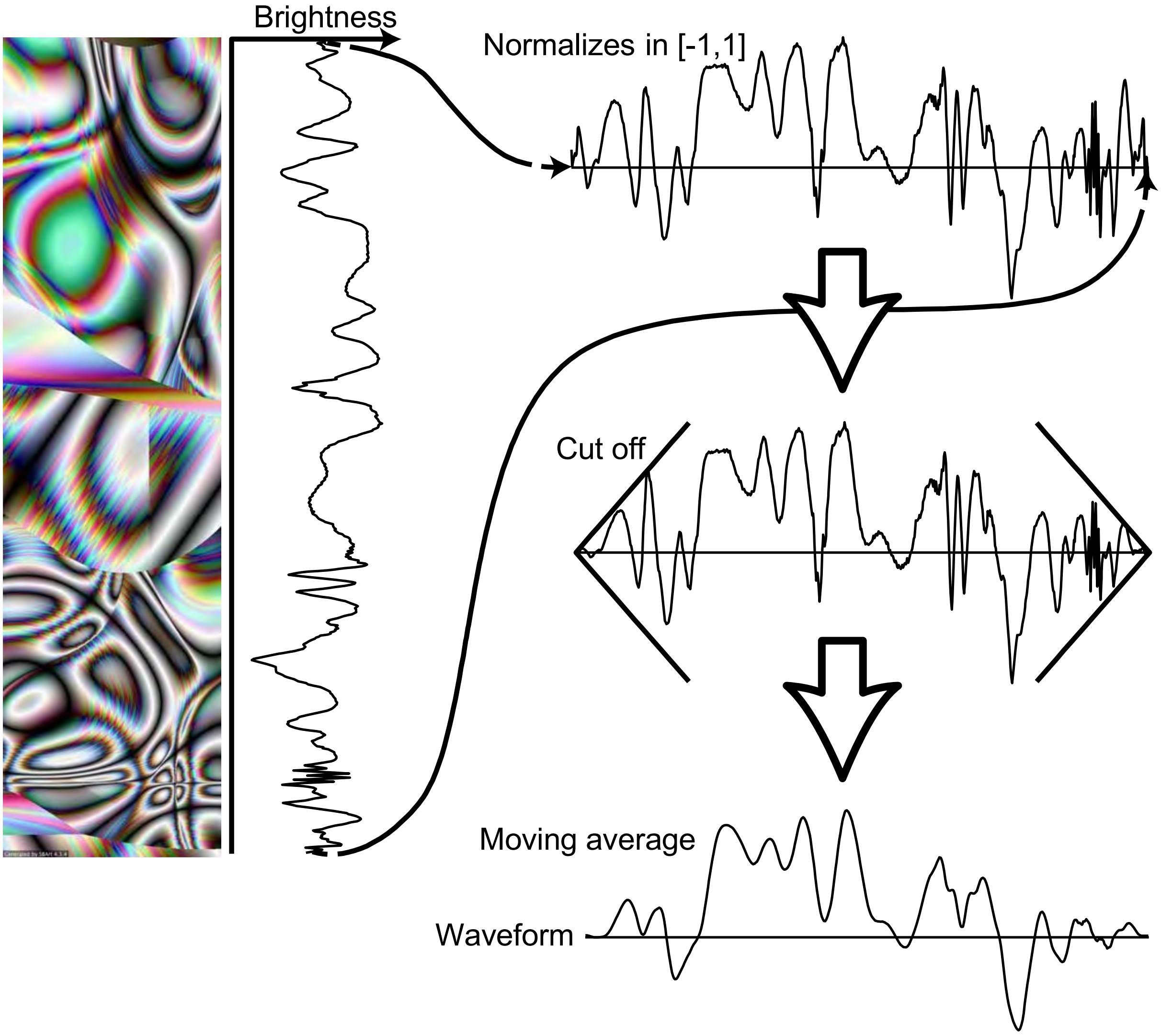

Figure 2. *The first method for synthesis of the waveform.*

$$s_t = \frac{1}{12}\sum_{i=1}^{12} B_i \gamma^{i-1} \sin 2\pi \cdot \phi \cdot t \cdot i \qquad (2)$$

where B_i is the average brightness in the ith row in the sub-region, and φ is a coefficient for the base frequency of the sound that is determined from the average brightness in the sub-region, the range of sound frequencies, and the sample rate.

These two methods produce different timbres, but the common characteristic is that a smooth image pattern makes a clear sound by sine curves and a complicated pattern makes a sharp sound by complicated waveforms. In the latter case, the sound includes a component of high frequency.

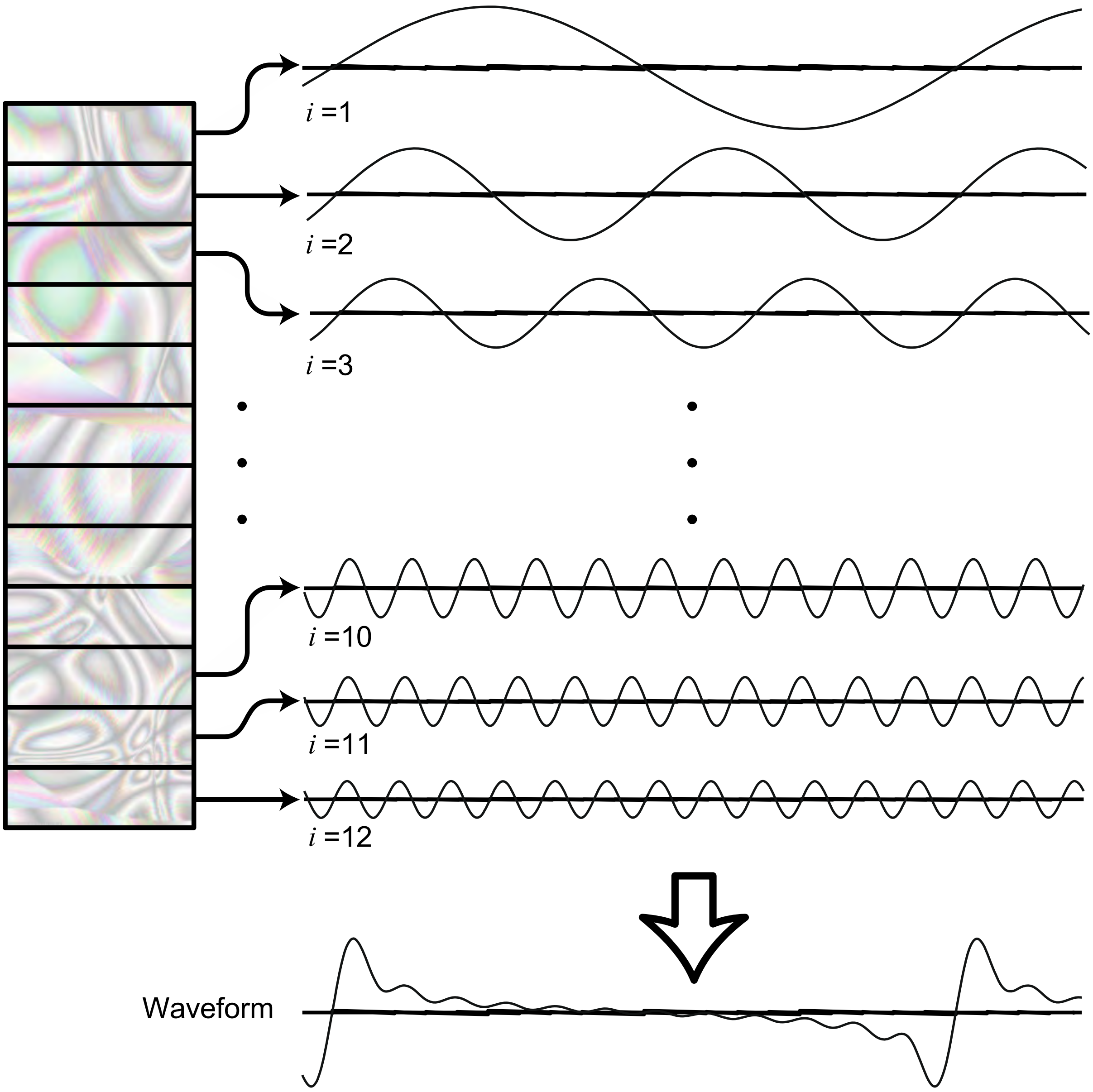

Figure 3. *The second method for synthesis of the waveform. It takes weighted summation of 12 harmonic overtones.*

4. Sound modulations

It is useful to introduce a variety of parameters for sound synthesis in order to emphasise the changes of visuals even if there is no obvious association between the features in image and sound. The statistical factors we use in the current implementation are (1) the standard deviation of brightness, (2) the average and (3) the standard deviation of saturation, (4) the average and (5) the standard deviation of hue values over all of pixels in the sub-region, (6) the average of variances for brightness for each row, (7) the horizontal and (8) vertical position of the center of gravity on brightness. The target parameters of sound synthesis corresponding to each of these statistical factors are (1) bandwidth of low-pass filter for basic waveform, (2) frequency and (3) strength of amplitude modulation, (4) frequency and

(5) strength of frequency modulation, (6) phase shift between left and right channels, (7) time delay of attack for musical note (8) tail length of envelop. The last two parameters are applicable only for musical sound described in the later section 5. These correspondences are not effective when the statistical factors in the image are stable, but they are very effective when the factors are dynamically changing. The ranges of sound parameters are adjustable by human as described in the later section 6.

5. Automatic music composition

Human being has a long history of sound design for the life. The voice is an important for communication; the bell, chime, whistle, siren, etc. are useful for warning and attention; and the music is enjoyable in a festival and a ceremony.

Using the methods of sound synthesis described above, it is possible to produce a sound continuously changing because the parameter values extracted from frame images are also changing as the frame alternation goes on. The usual frame rate of smooth animation is not fast enough for continuous change of sound, that is, it sounds changing stepwise when the same parameter values are used until the next frame is displayed. To make the sound changing smoothly, we introduce a mechanism of interpolation between parameter values in consecutive frames in the animation. A simple linear interpolation is effective enough for this purpose.

Such a continuous sound is interesting but it sometimes sounds scary for audience, typically for young children. One method to make the installation enjoyable for wider audience is to modify the sound to be more musical, that is, the sequence of separated notes expressing melody, harmony and rhythm. By quantization of the continuous sound stream, it is divided into a sequence of separated notes each of which has a pitch of restricted set of frequencies.

The variation of pitches is chosen from the candidates of harmonic and alternated musical scales, such as pentatonic, major, blue notes, whole notes, diminished, and chromatic. In the piano and the other keyboard instruments and chromatic percussion the pitches are fixed, but it is usually possible to bend the pitches in the other types of instruments such as strings, horns, and talking drums. To add such flexibility that useful to make the sound more expressive, we introduced a partial frequency alternation of each note as to be gradually changing toward the continuous frequency extracted from the current frame. The rate of alternation is also a subject to adjust by human.

We implemented two alternative methods to make a rhythm. One method is to use a random sequence of three types of marks, note on, note off, and continued. These marks are applied in constant tempo in the order they are arranged when the system generates the sound. “Note on” starts a new note, “note off” stops the current note if it exists, and “continued” keeps the current on/off state. A sequence is arranged for each sound sources independently in the same number of timings such as 16 beats. It is easy to make an interesting rhythm pattern by random generation under constraints of appropriate probabilities for each mark. We implemented a pattern editor shown in figure 4 that allows the user to design his/her favourite rhythm pattern.

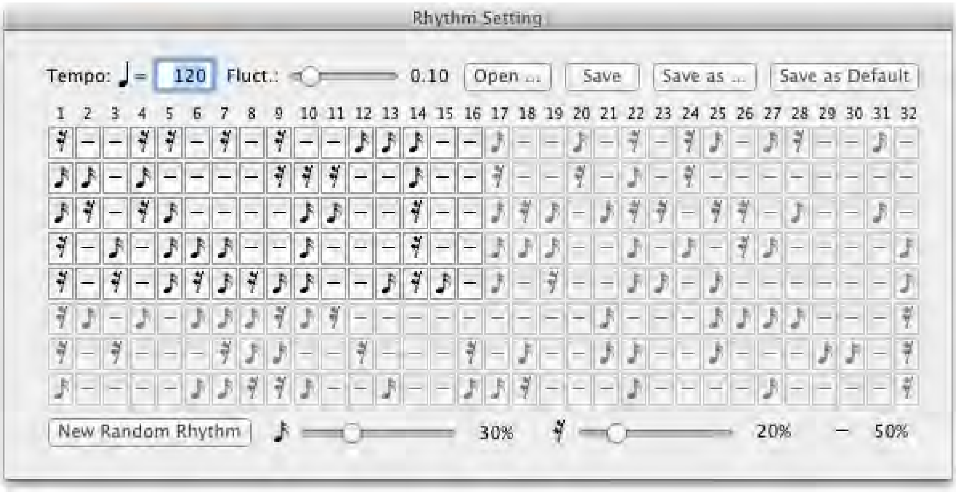

Figure 4. *GUI of rhythm editor.*

The other method is to start a new note when the image changes faster than a threshold speed if the time longer than minimum limit of note duration has passed since the proceeding note started. This method does not produce a pattern of constant tempo but a type of synchronized rhythm with the motion in the frame images. It is more effective to emphasize the impression of visuals than the first method.

Another important factor for musical notes is the envelope that determines the time alternation of loudness for a single note. Usually, an envelope is defined by some parameters to draw a relation between time and amplitude, but we use only two parameters for the time delay of attack and the length of tail in the current implementation as shown in figure 5. If the delay is long, the note sounds like bowing on strings or normal blowing on horns. It sounds pizzicato on strings, piano or guitar, when the delay is short. The amplitude of each note decays exponentially by multiplying a coefficient. The long tail sustains the sound for long time until it explicitly stops or the next note starts.

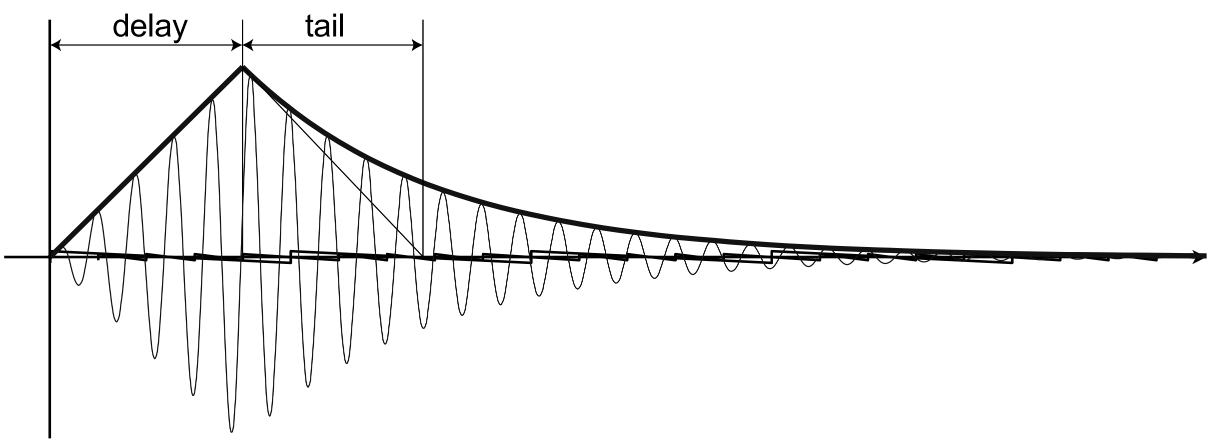

Figure 5. *Parameters for envelope.*

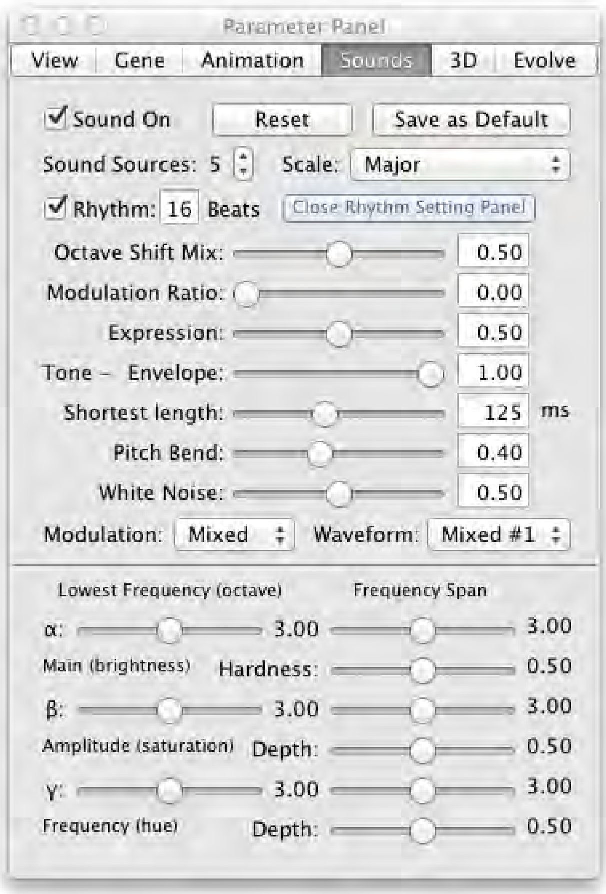

Figure 6. *GUI for parameter alternation for sound synthesis.*

6. Adjustable parameters

As described in the former sections, the user is allows to adjust some parameters for sound synthesis to add his/her favourite taste. These parameters include the frequency ranges of pitch, amplitude modulation and frequency modulation within the range of audible frequencies for human ears. The bandwidth of low-pass filter and the modulation strengths of both amplitude and frequency are targets alternation by the standard deviations of brightness, saturation and hue as described in former section 4, but their maximum values are also adjustable by the user. The statistical features are ignored when these maximum values are set to zero.

Figure 6 shows the window image of graphical user interface to adjust those values. It contains a stepper for the number of sound sources, a popup button to choose the musical scale, a checkbox to determine if rhythmic or synchronous, and a text field to input the number of beats for random rhythm pattern. The slider entitled “octave shift mix” is to indicate the mixing ratio between original tone and the tone of which pitch is shifted in octaves as described in former section 2.2. The shifted tones are not mixed when this value is 0, and the sound is constructed only from the shifted tones when it is 1. The next slider entitled “modulation ratio” is to control the ratio of strength of modulation between the original tones and the shifted tones. As described above, the maximum strengths of each modulation are limited by the other parameters, but this parameter is to multiply one more coefficient either the original tones or the shifted tones. The combination of coefficients for the original tones and the shifted tones becomes one and zero when this parameter is 0, one and one when it is 0.5, and zero and one when it is 1. The sliders entitled “expression,” “envelope,” “pitch bend” and “white noise” are to indicate how much each effect should be applied. If the expression is set to 0, the motion speed in the visuals does not affect the amplitude of the sound.

Two popup buttons under these sliders are to alternate the method to apply the parameter values for each sound source. It would be better to allow those parameters separately for each sound sources in order to produce richer variation of sound output, but we would need to solve the problem of complicated operation on a large number of parameters by the user. To avoid this problem, the popup button entitled “modulation” allows choosing the direction of parameter value alternation corresponding to the statistical features extracted from the image. The parameter value increases when the feature value increases in the normal mode, but it goes in opposite direction in the reversed mode. In addition to the choices applying the same direction for all sound sources, the mixed mode is allowed so that the directions are alternated between odd columns and even columns. The other popup button entitled “waveform” allows changing the combination of methods for waveform synthesis for each sound source. It contains four alternative choices to apply the first method in section 3 for all sound sources, the second method for all, the first method for odd columns and the second method for even columns, and the first method for even columns and the second method for odd columns.

All of these parameters are registered as the properties belonging to the sound controller object in the framework of AppleScript, so that another application software is allowed to refer and change the values via inter-software communication. This feature is useful for a batch process of automatic production to construct the audio track in a movie file as a final product of the animation. By choosing random settings for each production, it is possible to make audio tracks of various different favours.

7. Concluding remarks

A method to automatically produce a sound from real-time animation was described above. The design of the mechanism is based on mappings the impression from the visuals to the audio using statistic analysis of the image and motion and a parametric method of sound wave synthesis. Through several times of application, this method seems successful to achieve an acceptable quality.

There is a wide range of possible variations for this kind of mappings. There are many alternative methods to extract the visual features from the motion image. Our second method to synthesise the waveform described in section 3 is similar to the method proposed by Dannenberg *et al* [6], but the combination of the other features are of course useful to produce richer sounds. If we would employ a method to trace a movement of typical image fragment, it could be possible to implement a moving sound source of which channel balance follows the position in the sound scape.

There are also alternative methods for sound synthesis. One obvious method is to use a set of audio filters connected each other. The features of visuals would be applicable to the filters as the parameters such as the bandwidth for low-pass and high-pass filters, decay and delay for echo, amplitude for distortion, and so on. Another possible method is to use MIDI instruments. It is easy to organize a virtual band by arranging a number of instruments to apply a melody, harmony, rhythm and other controls to play a type of music automatically composed in real-time. Some of the sound programs embedded in the MIDI standard other than musical instruments are also useful to produce an ambient sound.

It must be helpful to develop a type of graphical user interface to arrange the image filters, audio filters, and other processing units in order to examine a large number of possible combinations, similarly to some programming tools such as MAX and Pure Data.

The proposed method was designed for evolutionary animation, but it is also applicable for sound synthesis from any type of moving visuals. It might not be suitable for a video image captured in ordinary sceneries because the viewer would expect a sound of physical objects shown in the scene. However, we think there are many possibilities of potential applications for art and entertainment such as an interactive installation, a visual audio game, movie authoring, and so on.

We have been organized three types of application of this system so far, a live performance of real-time breeding, an installation of automatic evolutionary animation, and a web-based art of daily evolutionary animation. The first one of the previous version was performed in the Generative Art Conference in Rome in 2011, the second one is exhibited in the same conference of 2012 in Lucca, and the third one is exhibited on the Internet accessible at the web page of “SBArt4 Daily Evolved Animation on WebGL [7].”

This web site is designed using the latest web technologies of HTML5, JavaScript and WebGL. You can enjoy ten new animations everyday without any image loss by compression on the large screen if your machine has a recent product of graphical processing unit for high definition TV. The captured video of live performance, the summarized explanation of exhibition, and daily and weekly digests of daily productions are also available at the author’s YouTube channel [8]. The software SBArt4 is runnable on MacOS X 10.6 or later. The binary code is available from the “SBArt4 Home Page [9].” We hope that it will provide some inspiration to as many persons as possible.

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Valery Vermeulen

(Paper) **The EMO-Synth, an intelligent music and image generator directed by human emotion-**

Topic: interactive multimedia & generative systems

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Abstract:
This paper gives an overview of the EMO-Synth project, a project focusing on generative music and image generation, biofeedback, artificial intelligence, affective computing, advanced statistical modelling and creative evolutionary systems.
The EMO-Synth is a new interactive multimedia system capable of automatically generating and manipulating sound and image to bring the user in certain predefined emotional states. During performances the emotional responses of the user are measured using biosensors that register certain psychofysiological parameters such as heartrate (ECG signals) and stress level (GSR signals).

The paper is organised in three parts. In the first part we give description of the EMO-Synth, its functioning and background. This part includes an elaboration of the functional diagram as well as a detailed description of the organisation of performances with the EMO-Synth. The second part of the paper focuses on the music generating engine that lies at the heart of the EMO-Synth. We start with a description of the genetic algorithm and other computational techniques that have been used. Subsequently an overview is provided of the three sources of music generation; digital audio streams, music generated using the MIDI protocol and finally sound generation by virtual scores directing live musicians. The third part of the paper deals with a general discussion on how generative arts can extend the human creative process as well as how the integration of human (creative) interaction can provide humanised generative systems. In this discussion the EMO-Synth will be used as a key example.

EMO-Synth performance at Center for Digital Cultures & Technologie (iMAL, Brussels, Belgium)

The EMO-Synth project was realised with the support of the Flemish Audiovisual Fund (www.vaf.be), Flanders Image (www.flandersimage.com) and Center for Digital Cultures and Technology (www.imal.org)

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Keywords:
affective computing, generative music and image generation, creative evolutionary systems, genetic programming, artificial intelligence, statistical modelling and biofeedback

The EMO-Synth, an intelligent music and image generator directed by human emotion

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Abstract

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1. The EMO-Synth

1.1 Short description

Figure 1: EMO-Synth performance at iMAL (Center For Digital Cultures and Technologies, Brussels, BE, 2011, picture by Tom Van Laere)

The EMO-Synth is a new interactive multimedia system capable of automatically generating and manipulating sound and/or image to bring the user in certain predefined emotional states. (for a thorough overview and discussion on interactivity see [1]). During performances the emotional responses of the user are measured using biosensors that register certain psychophysiological parameters such as heart rate (electrocardiogram or ECG) and stress level (galvanic skin response or GSR).

1.2 Practical use

Figure 2: the EEG Trainer by Mindmedia B.V.

Using the EMO-Synth involves two phases: a learning phase and a performance phase. In the learning phase the EMO-Synth will generate auditory artefacts for the user being attached to biosensors (for the project these are the EEG Trainer and bio-trace software by Mindmedia B.V.). Using the measurements of the bodily reactions the system subsequently analyses the resulting emotional impact of the artefacts onto the user. By means of machine learning techniques and statistical modelling the EMO-Synth will learn in an adaptive way to generate those sounds and music that bring the user in certain pre-chosen emotional states. During the learning phase the user has his/her emotional feedback matched to generated sound using artificial intelligence models constructed by the EMO-Synth. After the learning phase has passed, the artificial intelligence models contain an emotional response profile for the same user. The EMO-Synth is then ready to be used as a realtime responsive multimedia performance tool in the second phase that we will call the performance phase. During these performances the models which were constructed in the learning phase are used to produce realtime personalised soundtracks for live visuals. The soundtracks involve not only digital audio but also live musicians. Visual material is hereby partially generated by the EMO-Synth and partially controlled by the same person as in the learning phase placed in front of an audience. The live audiovisual concerts that result from this experience tend to be unique and entirely based on the emotional feedback and profile of the user. During every performance the EMO-Synth is programmed to maximise the emotional impact of generated sound and image on the user.

1.3 Functional diagram

To provide the reader with a mind map we include a theoretical functional diagram of EMO-Synth and its functioning which we shortly discuss.

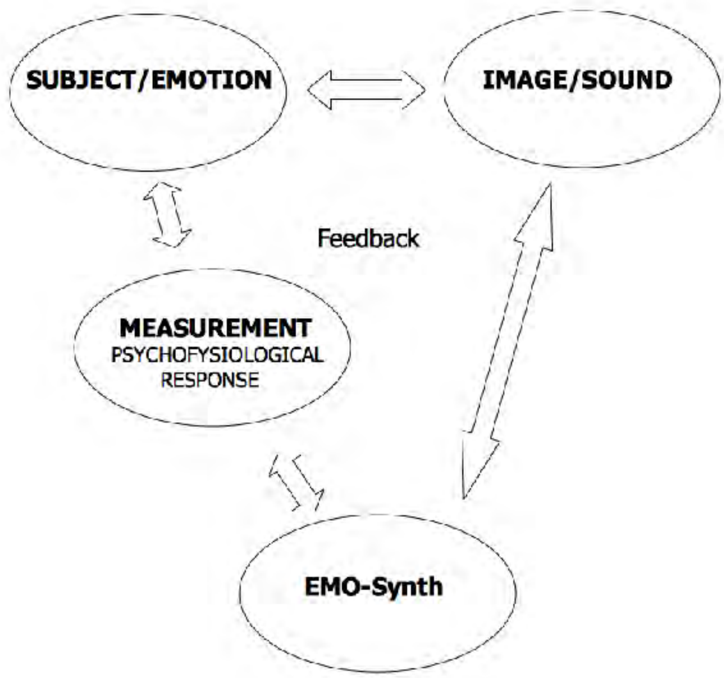

Figure 3: functional diagram of EMO-Synth

The subject is attached to biosensors that measure his or her psychophysiological reactions. Subsequently the EMO-Synth generates sound and image evoking emotional reactions with the subject. The reactions are fed into the EMO-Synth. The system learns from these reactions (in the present case this concerns an offline learning process) and starts to generate new sound and image and the cycle starts all over again. During this process a feedback loop is established between the subjects' emotional reactions and the images and sounds that are being generated. As the reader will notice in the further description, up to now image generation should be considered as a realtime manipulation of automatically generated video material. For the next generation of the EMO-Synth this image generation process will be extended to include generative algorithms as well.

1.4 Background and musical diversity

Figure 4: EMO-Synth performance at art cinema OFFoff (Ghent, 2009, BE, picture by Tom Van Laere)

Due to its interdisciplinary character the development of the EMO-Synth relies on a broad range of scientific and artistic disciplines. These include affective computing, artificial intelligence, statistical modelling and algorithmic sound and image generation. The idea and subject behind the EMO-Synth project is not new and relies on a long history of use of biofeedback for the arts. Among the first to use biofeedback we can mention the visionary artist A. Lucier with his ground breaking *Music for Performance (1965),* the pioneering work of D.Rosenboom, author of the essential *Biofeedback fort he Arts, Results and Early Experiments* ([11]) and R. Teitelbaum with his *Spacecraft* installation in 1967. From the sixties biofeedback has been used in various artistic settings and contexts. In a lot of cases though biofeedback data is used as input data in a non-responsive sonification or visualisation process. In this way the data is directly translated into sound or image. Keeping this in mind, the EMO-Synth project provides a new dimension to this paradigm. Music and sound generation in the EMO-Synth entails much more than a simple data translation. The system really tries to understand the emotional responses of the users to sound or music and stores this information in appropriate artificial intelligence models. These artificial intelligence models are at the very heart of the music generation algorithm in the EMO-Synth. In order to allow for maximal flexibility music generation incorporates different sources: MIDI based musical data-streams, sample based audio-streams and live musicians by virtually generated scores. Due to the implementation structure of the system the music and sound that is being generated by the EMO-Synth can be immensely diverse: from tonal jazz or pop music over more textual soundtracks to real experimental avant garde music. In this way the variety in personal musical taste is embedded as much as possible into the generative system of the EMO-Synth.

2. Music and image generation

In this section we will go into detail with regard to the sound and image generation engine that is used in the EMO-Synth.

2.1 Three sources for music and sound generation

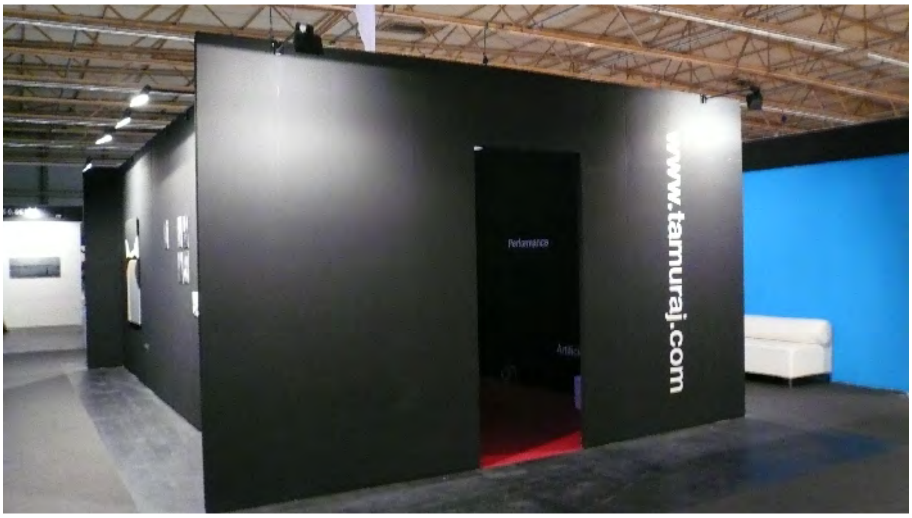

Figure 6: EMO-Synth performance at art fare Lineart (Ghent, BE, 2007)

Music generation during EMO-Synth performances includes three sources. All these sources can be combined according to the choice of the user. A first source consists of digital audio material which is organised in a database. For music generation this database can be consulted by he EMO-Synth. The audio material in this collection can completely be customised. Working with the database will moreover enable any artist to use his/her own audio clips during a performance. The second source of music/sound generation is implemented through the use of MIDI data streams. MIDI data is being generated by the EMO-Synth and sent to several MIDI channels. These

MIDI channels can comprise percussive lines as well as harmonic and tonal material. For sound generation the MIDI data is send to appropriate soft or hardware synthesisers. A third and final source of sound generation involves the use of live musicians. During performances, if desired, the EMO-Synth can generate realtime virtual scores. That way, live musicians can be directed by the system using these scores. Thus, the EMO-Synth becomes a realtime composer directing these live musicians using the scores.

2.2 Music and sound generation during training an performance phase

As already briefly mentioned using the EMO-Synth involves two stages; a learning and performance phase. During the learning phase the EMO-Synth will learn how to bring the test person into four different states of arousal, in particular: a state of low arousal, a state of low average arousal, a state of high average arousal and a state of high arousal. The motivation to work with states of arousal can be found in general emotion psychology. According to most researchers in this field human emotions can be categorised using the two dimensions valence and arousal. Valence pertains to the positive or negative effect of an emotion and arousal to the intensity (for information on these dimensions we refer to [7, 8]). As the measurement of the valence component cannot be realised using classical biofeedback devices we chose to only work with the arousal component of the emotional state in the EMO-Synth project. For the practical implementation to build and store knowledge between music generation and emotional response, statistical modelling, genetic programming (cf.[4, 5, 6]) and the approach followed in the design of creative evolutionary systems (cf. [2]) are used. After the learning phase the knowledge is stored in so called artificial intelligence models. Every model in the same vein contains a statistical musical model that is central for music generation. Different artificial intelligence models will entail a different kind of musical genres. It are these artificial intelligence models that are trained by the EMO-Synth during the learning phase. The training hereby is implemented using genetic programming. In the genetic algorithm the artificial intelligence models are the individuals in the evolutionary pools that evolve under the darwinistic rules of survival, cross over and mutation. How survival, cross over and mutation affects the artificial intelligence models is hereby programmed into the EMO-Synth. Once the learning phase has passed the EMO-Synth is ready to be used in the performance phase. During the performance phase the EMO-Synth will use its knowledge on emotional reactions of the user captured in the trained artificial intelligence models to compose appropriate sound and music.

2.3 Image generation and manipulation

Figure 7: EMO-Synth performance at Logos Foundation (Ghent, Be, 2012)

The video generation during performances of the EMO-Synth depends on the following strategy. Initially source material is chosen and cut into consecutive video clips. The clips are cut in such a way that every clip expresses one outspoken emotional state. By doing this video clip can subsequently be annotated according to its arousal level or quality; i.e. video clips with low arousal quality, video clips with low average arousal quality, video clips with high average arousal quality and video clips with high arousal quality. Next, these video clips are designated to a database inside the EMO-Synth. Once a performance starts the EMO-Synth will compose a movie using the video clips from this same database. At the same time music and sound is generated by the system that has the same effect onto the user as directed by the annotations of the video clips. In order to monitor the actual effect the audiovisual stream has onto the spectator the visuals are partially manipulated by his or her stress level. The more stressful he or she gets the more distorted the visuals will be.

3. Generative arts, human creativity and the EMO-Synth project

As a generative sound and video generating engine the EMO-Synth is an example of how connections can be established between generative arts and human creativity. By using human input generative arts can be provided with a human factor. If one establishes this link by the use of human emotion as input source new links arise between human creativity and generative arts. Moreover if emotions are used as input or during the generating process one introduces a very interesting and highly non linear factor into the work of art. A factor that is on the one hand not completely random or randomly generated but on the other hand not completely predictable or programmable. It is this form of hybrid coexistence between software and emotion as human factor that also form the basis of the EMO-Synth project.

In order to establish the link between emotion and generative art works two domains are crucial. The first is the domain of psychophysiology and biofeedback. In this field researchers are looking for ways to measure human emotional states by means of biosensors that measure certain psychophysiological parameters such as ECG (electro cardiogram or heart beat), GSR (galvanic skin response or stress) and EMG (electro myogram or muscular tension). The second domain is the promising new field of affective computing founded by R. Picard at MIT (cf. [9, 10]). Originally build on the early work of M. Clynes (cf. [3]) researchers in affective computing are looking for new directions to establish emotional man-machine interactions. As affective computing heavily relies on accurate measurement of human emotions biofeedback and psychophysiology are widely used. During the last decade psychophysiological measurement devices became more and more affordable. As a result, research in affective computing is spreading from very specialised laboratories to worldwide teams or individuals looking for various applications.

As to the EMO-Synth project one might say that affective computing has been crucial for its development. I personally treated it as the perfect way to practically develop my own methodology of connecting generative audiovisual systems and human creativity. The crux of this matter is my belief that every artwork has a deeply embedded ability or inability to communicate by means of human emotion. This belief is and was also motivated by my work both in mathematics and music. Far too often art and science are put in juxtaposition. It is taken for granted that every scientist, and mathematician in particular, acts in an utmost rational way. Just like the work of the scientist would be only related to a smart and complex network of programmed routines on a digital system. However, no matter how clever networks are implemented they are and remain subject to the world of the rigid binary first order logic. It is in the light of this naive approach that generative arts are too often conceived as products of logically ordered routines and subroutines living in a digital programmed system. Such a point of view leads more than desirable to a discussion on the artistic position generative arts need to take. To this end, a common crucial question relates to the intrinsic value of an art work as soon as everything is programmed in advance and artefacts are produced by generative systems. On the other hand, the methodology of the artist is always doing its part. It draws upon his/her personal creativity and imagination and forms the essential part of the process towards an artistic result or product. In classical terms every artistic creation process is supposed to be non rational, unpredictable and highly non linear. As if artists hold the key to a primal creative alter ego that has to be mastered.

Having worked in both mathematical research and as a musician, I experienced time and again that the boundary between art and science is nothing but artificial. Thanks to my work I have gained the insight that both disciplines are manifestations of one and the same mental activity or state. To my believe, this state is closely related to the core of what is being considered as artistic creativity. The EMO-Synth project presents new ways to integrate this way of thinking into a concrete generative multimedia system that stresses both the rational and irrational part of human behaviour and it hereby provides a new dimension to the paradigm of generative production.

Figure 8: EMO-Synth performance at the Royal Conservatory of Ghent (Ghent, BE, 2010, picture by Tom Van Laere)

Bearing the previous discussion in mind, the two following basic principles inspired by the EMO-Synth project and related to the creative artistic process can be formulated:

- The integration of biofeedback and emotions in generative arts offer new ways for creating virtual tools by which an artist can extend or complement his or her own creative process. Generative arts can accordingly function as inspirational source and moreover provide an understanding of the creative process on a whole new level both by artist and audience.

- By using systems like the EMO-Synth a new platform arises in which boundaries between artist, audience and the generated artefact are redefined. To what extend are the artefacts generated by the system creations of the artist, programmer, author or machine? To what extend can we speak of artistic input once a generative system like the EMO-Synth participates in the creative process. To what level are these artefacts a creation of the audience, the machine or the artist-programmer? Who is the author of what is being generated or is there even an author?

From this discussion it is clear that integrating emotions into generative artworks is a tremendous promising field when it comes to including human artistic creativity Creativity in this context can therefore be found on several levels: on the level of the audience, on the level of the machine or on the level of the artist.

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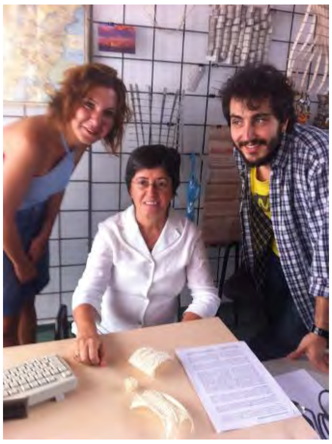
Yekta IPEK, Guzden VARINLIOGLU, Gulen CAGDAS

Paper: **AN ALTERNATIVE APPROACH TO STRUCTURAL OPTIMISATION IN GENERATIVE DESIGN**



Topic: Architecture

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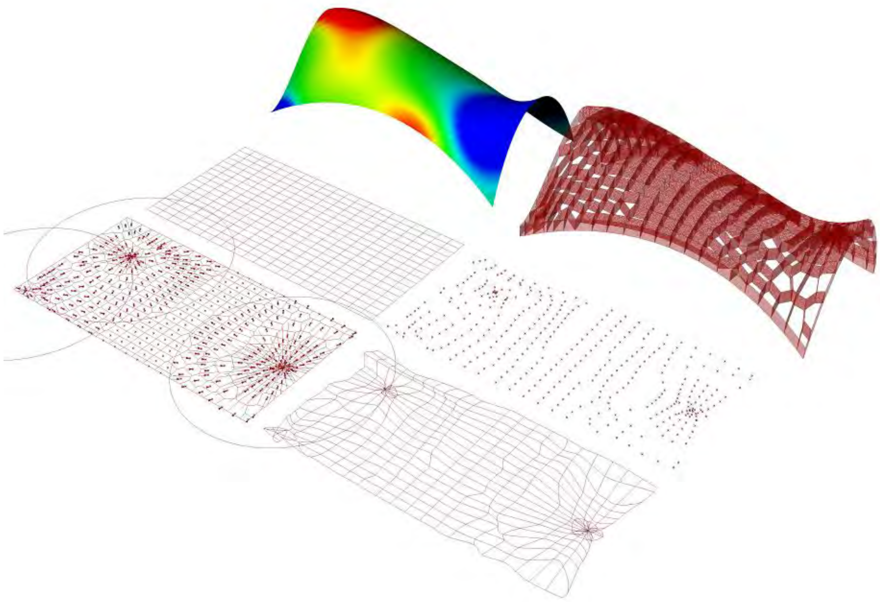
Abstract:
The paper presents a structural optimisation model that proposes alternative methods using generative approaches. Current methods of optimization are defined by three operations, such as modularity, repetition and differentiation. As an appropriate example of these methods, voronoi structure is explored for its potentials for optimization, form finding and structural performance. A voronoi is modular but not repetitive, with potential for a great variety of complex geometries. Using voronoi diagrams, the pattern in architectural design can be formed according to structural performance.

In this paper, a generative algorithm is proposed at initial design phases while designing a structure for a given surface. The structural performance data is converted into geometrical data on the double-curved surface to represent the structural values as an architectural pattern. At initial stages, the surface on which the pattern is formed, is analysed using the finite element methods to obtain values on the surface. Later, according to the data obtained, the surface pattern is generated using a generative algorithm, which is developed in Rhino/Grasshopper software. With the help of this algorithm, it is possible to create multiple solutions meeting the structural performance requirements besides one concrete optimized result. Thus, the proposed work also evokes alternative methods for the design decisions made in the preliminary design phase by means of generative methods.



Images of patterns created with the generative algorithm based on voronoi diagrams

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Keywords:
structural optimization, voronoi diagram, performance based design, form generation.

AN ALTERNATIVE APPROACH TO STRUCTURAL OPTIMISATION IN GENERATIVE DESIGN

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Abstract

The paper presents a structural optimisation model that proposes alternative methods using generative approaches. Current methods of optimisation are defined by three operations, modularity, repetition and differentiation. As an appropriate example of these methods, voronoi structure is explored for its potentials for optimisation, form finding and structural performance. A voronoi is modular but not repetitive, with potential for a great variety of complex geometries. Using voronoi diagrams, the pattern in architectural design can be formed according to structural performance.

In this paper, a generative algorithm is proposed at initial design phases while designing a structure for a given surface. The structural performance data is converted into geometrical data on the double-curved surface to represent the structural values as an architectural pattern. At initial stages, the surface on which the pattern is formed, is analysed using the finite element methods (FEM) to obtain values on the surface. Later, according to the data obtained, the surface pattern is generated using a generative algorithm, which is developed in Rhinoceros software and Grasshopper plug-in. With the help of this algorithm, it is possible to create multiple solutions the structural performance requirements besides one concrete optimised result. Thus, the proposed work also evokes alternative methods for the design decisions made at the preliminary design phase by means of generative methods.

1 Introduction

In the field of engineering, optimisation plays an important role to find the optimum solution. Generally, it refers to maximum or minimum boundaries of solutions to the problems that the designer faces during the problem solving activity. Similarly, the optimisation methods are mainly based on mathematical interpretations and relations related to the defined problem. There are two types of problem solving activity: well and ill defined problems. In well-defined problems, steps to the outcome are clearly defined, whereas in ill-defined problems, the specifications are clearly set. As stated by Eastman, the major distinction between well and ill defined problems is the “assumed availability of a specification process for defining the problem space” (Eastman, 1969: 669) [1]. Thus, optimisation methods are deeply linked with well-defined problems instead of ill-defined problems.

Optimisation is one of the techniques used by engineers to define the solution range set for the problem. However, in the field of architecture, designers deal mostly with ill-defined problems. They predominantly focus on the methods to enrich both the design processes and the outcomes. In that sense, generative methods facilitate the design process by helping the designer to find the optimal solution. Generative methods in which the output is generated by set of rules or an algorithm, and normally by a computer program, named also as tools, are generator for the designer during the design process (Shea, 2005: 254) [2]. Using the implicit capabilities of generative methods, the number of solution sets is increased.

1.1. Deterministic vs. Stochastic Approaches

Deterministic approaches and stochastic approaches are two design methods used during the problem solving process in the ill-defined problems. Similarly, deterministic algorithms are used as exploratory algorithm when there is a clear inside into the nature of variables. Stochastic algorithms are used in problems when there are uncertainties in the elements, the search space or the path for solutions (Barros, et al. 2012) [3]. Thus, the deterministic approach commonly used while stochastic approach has limited use in the architectural design. Deterministic approaches in architectural design leads the designer to arrive to concrete solutions and to produce one exact solution based on the data driven from the parameters. If no change occurs in the parameters, the solution does not change. Thus, randomness has no place in finding the final solution.

As opposed to deterministic approach, the stochastic approach includes randomness. After processing each loop during the generative process of the design, stochastic approach creates diverse outcomes. This probabilistic result is the outcome of the randomness. Thus, stochastic approach helps the designer to use generative methods during the design process for augmenting various solutions.

To better clarify the distinction between deterministic and stochastic approaches, example of a hollow cube is displayed to be filled with intended design geometry (Fig.1). The design of infilling of the cube is based on geometrical rules. In the first approach, defined as the deterministic approach, the designer draws previously constructed and defined product in its mind. Imagining the final product, the designer codes the process in terms of geometrical and mathematical rules. The designer processes and implements the rules of form generation into a computer-based algorithmic model. In the second approach, defined as stochastic approach, the designer does not have to construct the final product in its mind and to code the design product in terms of mathematical and geometrical rules for the whole design process. The designer needs to construct only the behaviours or intelligences of the elements, creating the geometry inside the box. In this approach, design system simulates and processes the elements to create the geometry inside the hollow cube. While comparing the two approaches, we concluded that the deterministic approach brings one solution as opposed to stochastic approach bringing different design outcomes during each execution of the generative system. Thus, the stochastic approach gives the designer divergent design outcome and can be considered much more generative then the approach.

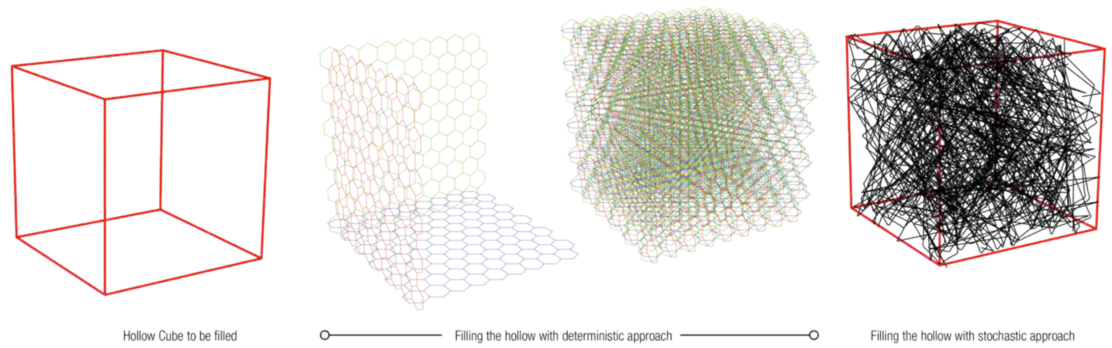


Figure 1 Strategies for the design of an infilling geometry of a cube.

1.2. Paradox between optimisation and generative methods

Optimisation techniques are used to find the optimum single solution to a defined problem. Generative methods are used to create more enriched solution sets during the design process. Optimisation follows the deterministic approaches whereas generative techniques tend to follow stochastic approaches. Thus, the contradiction between these two concepts, optimisation and generative methods should be further examined by defining the optimisation.

2. Optimisation

Optimisation is the search for optimum solutions. During the optimisation process, engineers pick the best solution for the problem regarding the constraints [4]. Optimisation methods help to define the solution domain boundaries by scaling down the solution set range. Moreover, optimisation is a decision-support system for the problem solving process to find proper solution in the solution set domain. Consequently, optimisation methods help to reduce the exploration time within the solution set containing numerous different solutions for specific type of problems.

2.1. Optimisation methods in engineering

Optimisation methods are highly associated with the field of engineering. Engineering deals with well-defined problems, with specifically defined inputs, goals and steps to reach the goal. Facilitating the problem solving process by narrowing down the solution set for specific problem, the methods have become useful and popular in the field of engineering in time. Moreover, the ease of interpretation of optimisation algorithms used for well-defined engineering problems makes the optimisation methods additionally powerful and useful.

2.2. Optimisation methods in architecture

In the contrast to the straightforward interpretation of optimisation algorithms in the field of engineering, the implementations of the optimisation methods in the field of design are complex in nature. The problems faced in architecture are mostly ill-defined; therefore, it is hard to interpret as an algorithm and to search for the solution of problems. Furthermore, the goals and steps for the problem can not be generally interpreted in a mathematical way, due to the nature of the problem. Optimisation methods delineate the design problems by making the solution set narrow down; thus, the optimisation methods might be considered as decision-support system within the design process [5].

3. Alternative Approaches to the Structural Optimisation in Generative Design

As the structural performance has to be optimised, the engineering requirements offer more than one single solution for the problem. At the initial stage of the design process, we proposed an algorithm in order to clarify the dilemma between generative and optimisation methods in structural performance. The proposed algorithm forms patterns along the surface of a structure and gives the designer an optimised relevant solution. This algorithm is based on voronoi polygons, as its cellular formation deforms the surface pattern by optimising the structural performance of the design product.

3.1. Operations

The pattern on the surface formed by the algorithm is defined by three operations: modularisation, repetition and differentiation. These operations, representing the geometric abilities of the pattern, are frameworks of the pattern formed for the structure. Using these operations, pattern can be modified and optimised according to the structural performance.

The first operation, modularisation is widely used for creating cellular formations. Considered as one of the main operations, modularisation is widely associated with grids to explore further geometries. In that sense, grids help to deform geometries of the modular systems, creating more complex and deformed patterns. The second operation, repetition refers to the growth of the system. In a holistic perspective, repetition and growth algorithms lead the system to diverse structural and geometrical solutions. Likewise, repetition overlaps with modularisation and growth of the system. Because of its close relation to the grid system, the growth algorithms have the ability to affect the grid system, which implies the ability to change the whole pattern. Finally the third operation, differentiation makes cells deform based to their locality and place in the system. By the help of the differentiation of intelligence, system meets the performance requirements within a predefined range. This operation helps the pattern to meet the performance requirements and to maximize the performance of the system. Therefore, this operation reduces complexity of the systems in terms of performance requirements and increases the efficiency of the design performance. To conclude with, these operations are the keys elements to reach modified and optimised solutions.

3.2. Technology

In this paper, we chose a pattern type, the voronoi, to optimise a design problem. A voronoi pattern is produced on a double-curved surface as a structural element. Voronoi pattern gives the designer a chance of optimisation within the critical boundaries of structural performance. As displayed below, voronoi pattern is formed and tested for several diverse grid types. The formation of point sets defines end product characteristics of the voronoi pattern. The ability for creating complex patterns of the voronoi pattern is highly associated with the grid formation.

Voronoi pattern behave differently on different grid layouts. For example on a square grid layout, the pattern forms itself as a square. After the deformation, the voronoi generates itself as a deformed pattern. The square cells remain as non-deformed grid while the voronoi patterns are created at deformed areas (Fig.2). Similar result is achieved while the general layout is in a polar or hexagonal form (Fig.3).

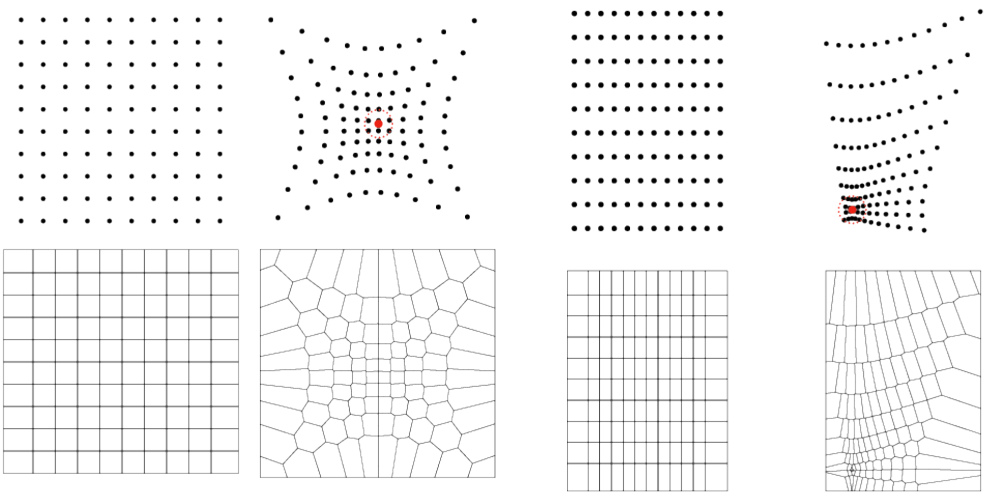


Figure 2 Deformation of the square grid

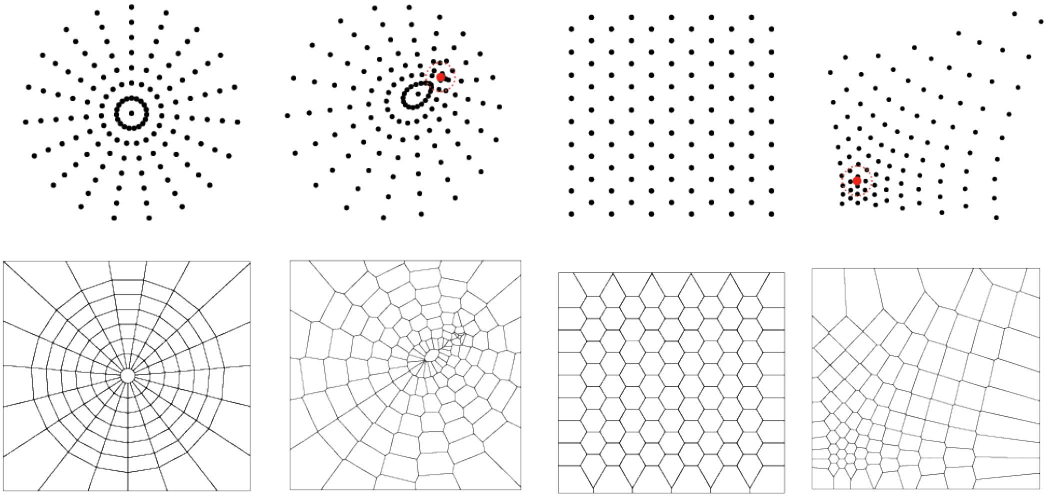
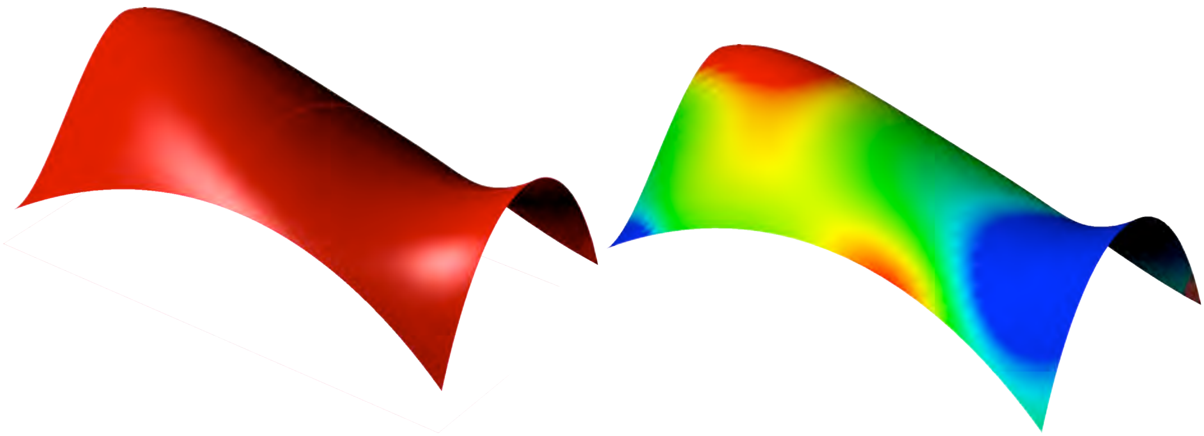


Figure 3 Deformation of the polar and hexagonal form

The model presented in this paper is created using Rhinoceros 3D modelling software, Grasshopper plug-in, finite element method software Elmer. The algorithm is implemented in Grasshopper 8.0.14, a generative modelling environment plug-in for Rhinoceros, 3D modelling software. First, the doubly curved surface, which is the base for the structure, is modelled in Rhinoceros. Second, the surface is analysed under given load conditions, in terms of structural stress by using finite element method software Elmer. The generated stress map defines the local behaviours of the voronoi pattern. Using the stress map, a grid is generated to form the pattern using modularisation and repetition operations.



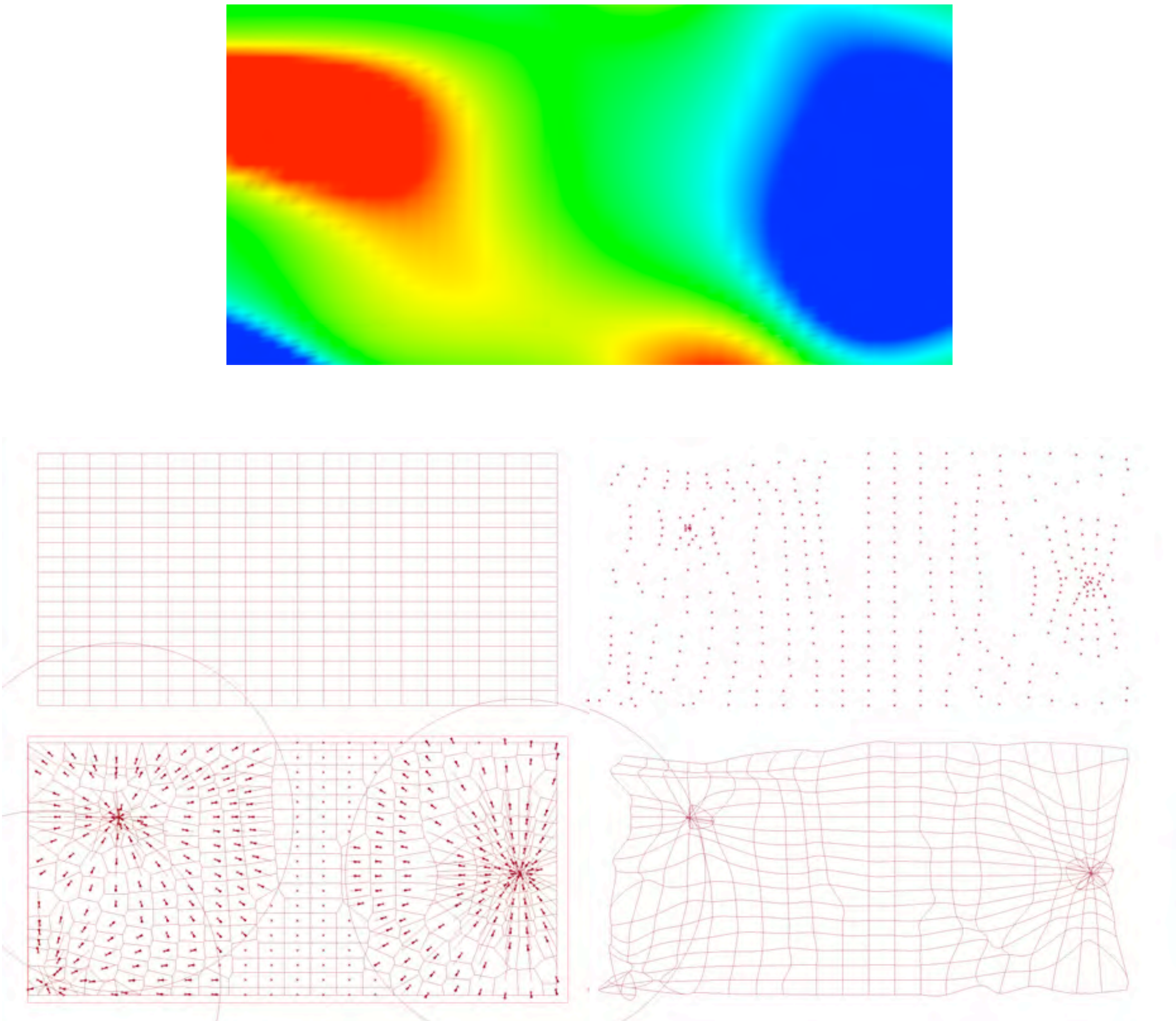


Figure 4 Images from the system: a. Modelled surface, b. Analyzed surface, c. stress map, d. Initial grid, e. deformed point set, f. deformed pattern and the control points, g. final deformed grid.

At this stage, the control points for the extremely stressed regions are significant as they deform the grid and consequently the voronoi pattern.

The control points of extreme regions refer to the deformation on the pattern. By clicking on the effect area, the designer can change the number of control points. This ability gives the designer the flexibility of using alternative optimisation approaches during the design process. At this level, the differentiation operation takes an important role as it forms the pattern relevant to the structural requirements. Differentiation operation both deforms the grid pattern and the point set of the grid (Fig. 5).

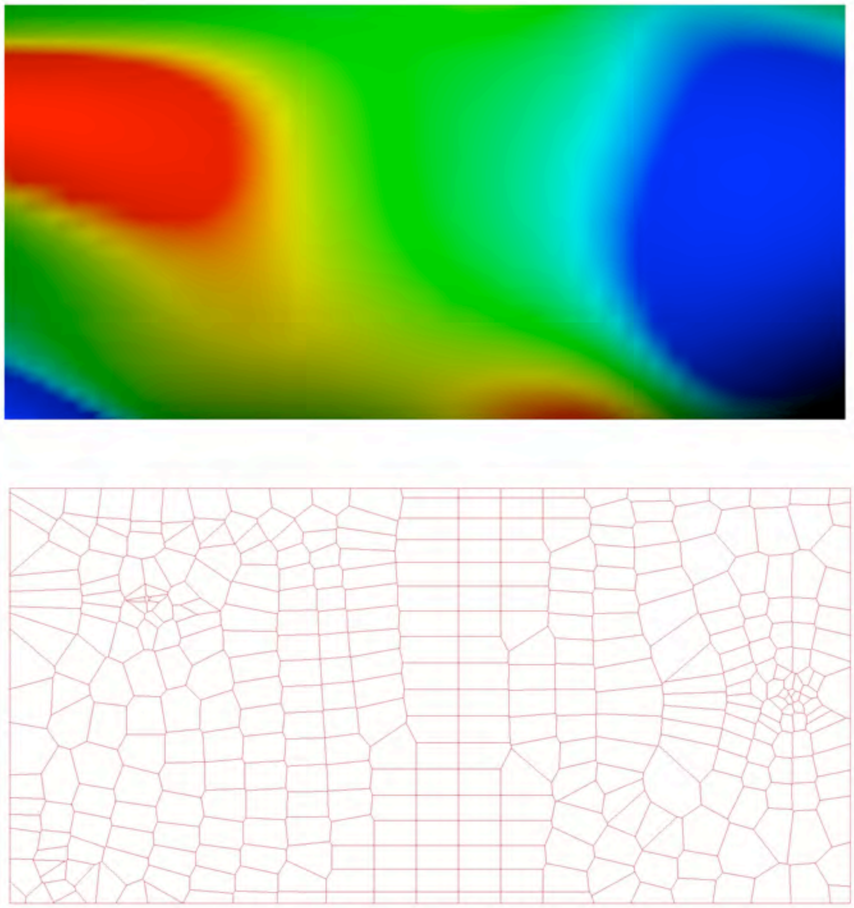


Figure 5 Structural stress map and the optimised voronoi pattern driven

After performing all the operation, the voronoi pattern is formed itself to meet the structural requirements of the system created along the doubly curved surface.

3.3. Tools

The designer is able to perceive the grid, the point set, pattern structural system, and the stress map simultaneously while using the proposed alternative optimisation approach. At initial design stages, the designer is able to form the pattern directly, and other components indirectly. Using the interface, the designer is able to control distribution and density of the control points that direct the deformation of the pattern. Thus, the designer can watch all of the deformations throughout the design production. Using this approach, it is possible to create multiple solutions meeting the structural requirement (Fig. 6).

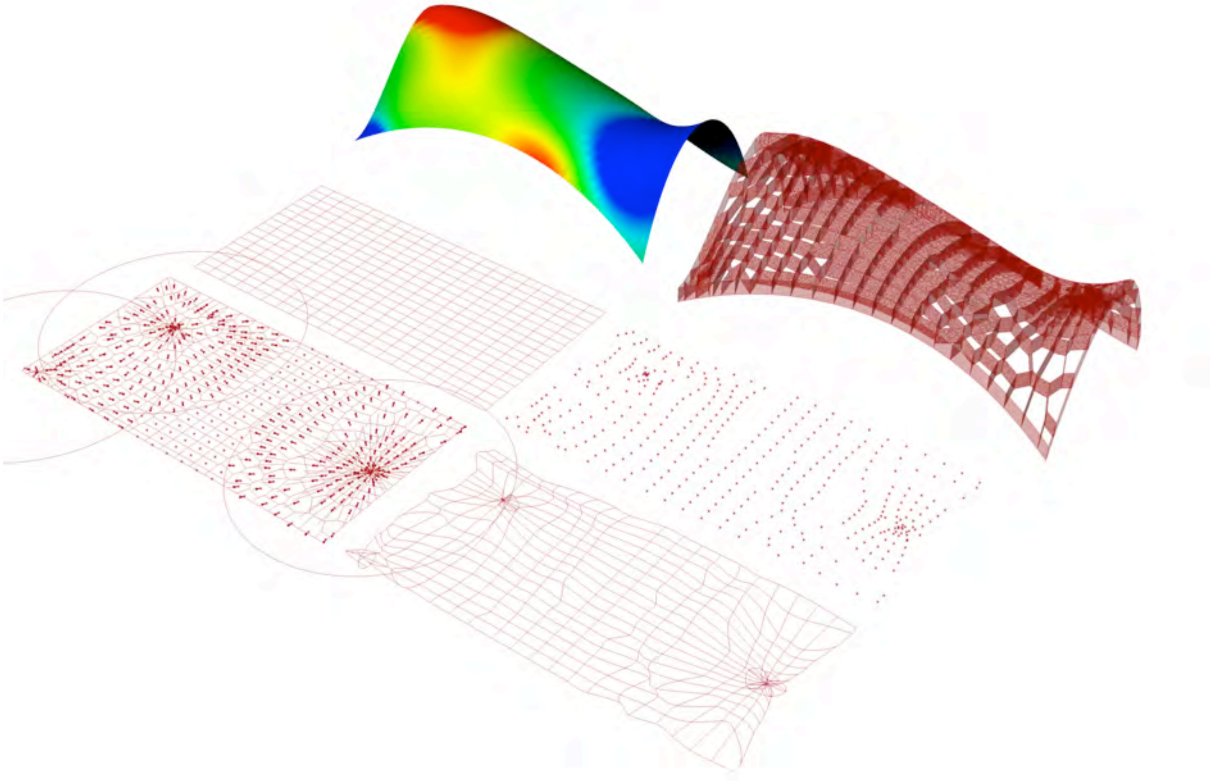


Figure 6 The proposed system

4. Conclusion

The operations that are coined in the paper help to construct the link between geometric and structural topics and help to remove contradiction between optimisation and generative concepts. By merging optimisation and generative concept, the paper demonstrates to extract the implicit structural and geometrical potentials of patterns as structures. Moreover, the proposed alternative optimisation method at the initial stage of the design process offers the designer a decision support system. The solutions generated by the system converge to the optimum solution, which meets the performance requirements. Therefore, the proposed approach reduces the time spent to make the design outcome realistic. Additionally, the proposed approach boosts generative methods by using optimisation methods and makes the design process more performance oriented. To conclude, the designer enriches the solution set around the convergent ones to the optimum solution by the help of the embedded performance intelligence.

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POSTERS, ARTWORKS, INSTALLATIONS

Alettia Vorster Chisin

Poster: **The social designer: a narrative vignette of lived experience in design teaching and supervision**

Topic: Creative Design Practice

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Abstract:

The poster discusses a section in a series of vignettes which I researched as part of my doctoral dissertation. Reflecting on a decade of teaching design, a space was opened up –a liminal and in-between space- which enabled me to re-examine the design landscape, including my teaching and personal experiences as a creative practitioner. Limen invited various moments, memories, ideas and concepts to be braided together so I could re-connect with my passion for teaching (paraphrasing Breen 2003:162) and creative expression.

I lived with questions in the study about the rationale for teaching students design. Traditionally a consumption-driven discipline, it is characterised by change and complexity but increasingly also by the sustainability discourse. Surface Design equally, is an elusive field to define. In this paper it is framed to bring a more holistic, if at times ephemeral measure to the work of design. Conceptual, applied or vocational, it stands firmly rooted in the traditions of art and of craft, with the concomitant 'higher order thinking' typical of design and its digital processes (Craft and Design Inquiry 2010). In this vignette I explore personal creative practice (and doing design) as a central aspect in theorizing design and in teaching/supervising in the form of life writing, poetry, collagraph and film.

The need to renew my own imaginative and creative base in art and design as research method became urgent as I developed the parallel layers of reflecting on teaching and writing about supervision. Doing design and art is different to theorizing design and art. I had to get my hands dirty and do: draw, make marks, etch, make prints, do imaginative field work. From this biographical point of view, by being both the researcher and the researched, as described by Heydon (2010), I filtered questions through the sieve of living them. Initial findings indicate that from an embodied perspective, facilitating the unfolding nature of design is more reliant on the lecturer/supervisor as active creative practitioner and researcher than it is on her expertise and content knowledge of the given design discipline.

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Keywords:
Narrative, Vignette, lived experience, design, supervision

Anna Chupa | *Artworks:* **TILINGS**

Topic: Art

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United States

References:
[1] Lu, Peter J., and Paul J. Steinhardt. "*Decagonal and Quasi-crystalline Tilings in Medieval Islamic Architecture*." Science 315 (2007): 1106- 1110

Abstract:
Tilings integrates 2D space, structured with fivefold symmetries inspired by Islamic “girih” tilings, and digital photographic materials drawn from Spanish Mudejar architectural details along with floral and other biological forms (e.g., fungus, lichen, seed heads, turtles and insects). Complex scenes digitally montaged then set into the tiling structure, create nonperiodic patterns exploring the interplay of photographic details visible in close-up views with abstract geometric forms that these details dissolve into at typical viewing distances.

Theoretically these patterns could tile infinitely without translationally symmetrical repetitions. This ties in with the metaphorical use of geometry in Islamic tiling to express divine infinity. The use of water, reflection and light in Islamic architectural space dematerializes form effectively as much as the elaborate tilings, screens and muqarnas. In this way, the individual patterns developed for *Tilings* are consistent with the aesthetic observed in Spanish Mudejar architecture.

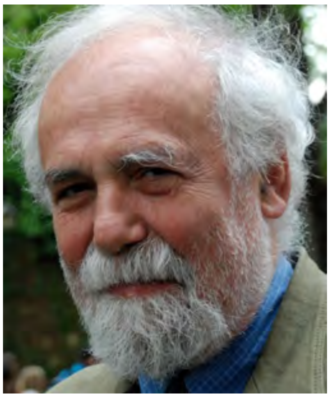
Other influences from medieval Islamic Spain include the emphasis placed on botanical studies and the importance of palace gardens. Hence, the use of floral material as subject matter, coupled with architectural details celebrates Andalusia but stops short of exact imitation through translating form into geometry that is itself a transformation removed from the historical instances of girih tilings.

Contact:
anna.chupa@lehigh.edu

Keywords:
Tiling, girih, symmetry, nonperiodic, Islamic

Celestino Soddu

Poster : **Logics of Imagination.**
Interpreting Lucca with Generative Art Scenarios



Topic: Generative Art

Author:
Celestino Soddu

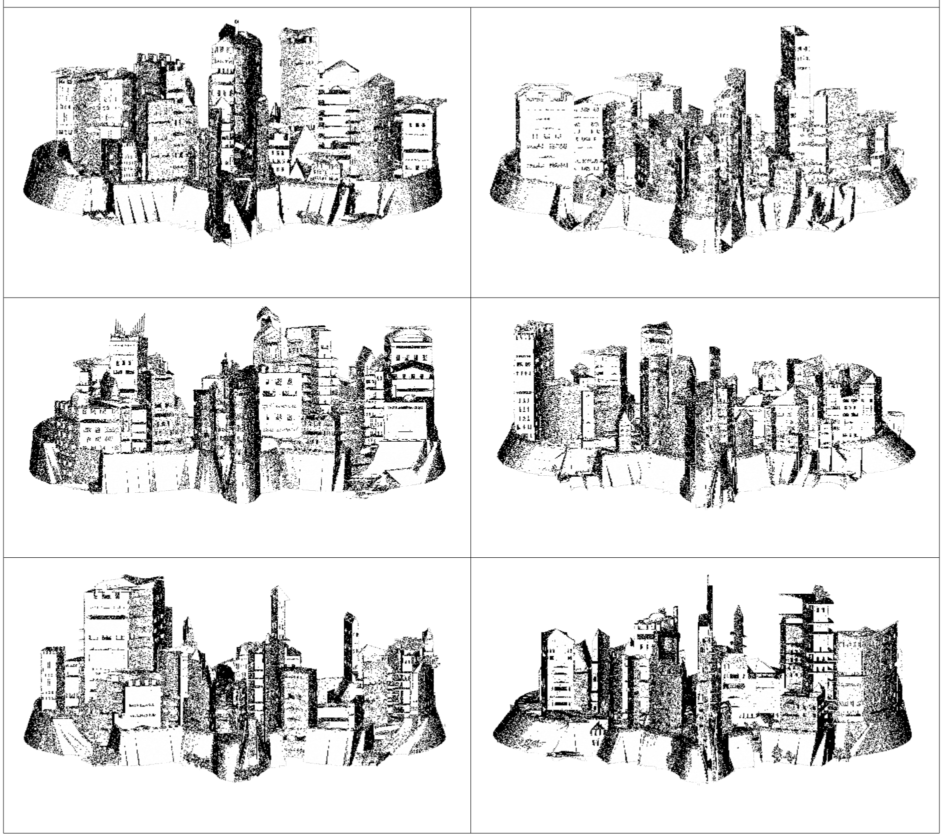
> Generative Art Lab.
Domus Argenia Center, Sardinia, Italy
> Generative Design Lab, Politecnico di Milano University, Italy
> www: generativedesign.com

References:

[1] C.Soddu, “Citta' Aleatorie”, Masson Pub. 1989
[2] C. Soddu, E.Colabella, “*Il Progetto Ambientale di Morfogenesi*”, Leonardo project, 1992
[3] Celestino Soddu, “*Milan Visionary Variations. Futuristic Meta Codes for Milan Identity*”, Gangemi Pub, 2005
[4] www.generativeart.com
www.soddu.it

Following my first Generative Art experiment about the generation of sequences of 3D models of Italian Medieval Town, published in 1989, I tried to identify my logical interpretation of Lucca, the city where we are for the 15th Generative Art conference.
The imaginary reference is not the actual town but the ancient drawings of Lucca, with its incredible towers all inside the city, Lucca was, for some centuries, one of the main Cities of Culture and its towers were a strong image of its time, as NYC was in the beginning of last century.
For gaining the urban complexity, the generative process must run a virtual history through different “historical” moments, sometimes in contrast one each other. Results are identifiable because the virtual history process is the same but each scenario gains its peculiar identity because the local contingent events start from different simulated time of beginning that interact with the parallel evolution of each transforming code.
For generating the 3D models, I used my old software Basilica, with some new algorithms focusing my interpretation of Lucca.
Basilica (written in 1986) is a program running in old MS Dos and able to perform an evolutionary process as virtual history developed by my logics of imagination.
I used these models for unique different covers of this book, each one dedicated to each participant at GA2012.

Interpreting Lucca with Generative Art 3D scenarios (C.Soddu, 11/2012)



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Keywords:
generative, artworks, identity, variations, complexity, casuality & random, imprinting, style, recognizability, clarity

Anna Ursyn

Artworks: **A Breakthrough, Architectural Impacts, Ecosphere, From the Village to the Big City, Timetable**

Abstract:
My computer graphics explorations serve as a point of departure for a series of prints or sculptures. I explore the dynamic factor of line. I transform an image of an animal into a simple image, an iconic object such as rocking horse or a symbolic picture of a bird, to present them in dynamic movement as the visible texture of the sky and the ground. In our visual planes of multiple horizons, every time we see the familiar image on the floor of ground and the wall of sky, soft and hard inhabit-ants sharing lots and acres; we see them as having common goals, and joining tasks.

Breakthrough

Ecosphere

Architectural Impacts

From the Village to the Big City

Topic: Art

Author: Anna Ursyn
University of Northern Colorado
Country USA
www.Ursyn.com

References:
Author(s)/Editor(s): Ursyn
Biologically-Inspired Computing for the Arts: Scientific Data through Graphics http://www.igi-global.com/book/biologically-inspired-computing-arts/60763www.generativeart.com Publication date: 2012.
www.generativeart.com

Contact: ursyn@unco.edu

Keywords:
Programming for art, photosilkscreen, photolithograph

Professor Anthony Viscardi

Paper: **Bio-Structural Analogies: Brazilian Design Workshop**

Topic: Architecture

Authors:
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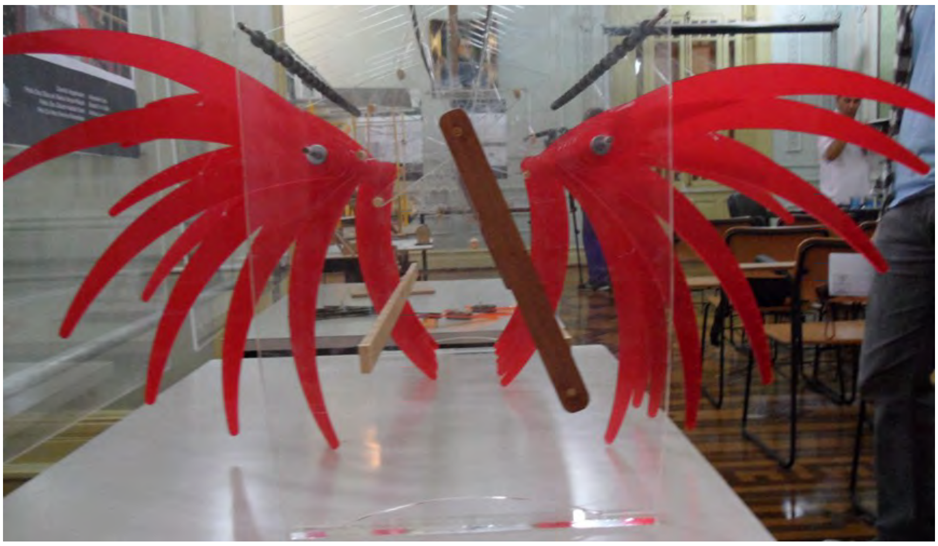
www.generativeart.com

Abstract:
This paper is an account of the experiences and accomplishments of a 7-day Intensive Design Workshop I conducted in collaboration with FAU (Faculty of Architecture and Urbanism) at the University of Sao Paulo, Brazil during their summer session in February 2012. Earlier in May of 2011, I was invited to conduct a series of lectures at FAUUSP after meeting several of their professors at an annual Generative Arts Conference in Milano, Italy, in December of 2010. The GA conference has been a very important facility to share pedagogies and to exchange ideas and faculty. I present this paper as a testament to this conference's virtues as a conduit for creative collaboration in the generative arts.

In collaboration with an organizing committee composed of Profa. Dra. Clice de Toledo Sanjar Mazzilli, Profa. Dra. Cibele Haddad Taralli, and Prof. Dr. Artur Simões Rozestraten, I drafted an outline and schedule to present and conduct this experimental design workshop during the month of February, 2012. Together we engaged the students in an invigorating design charette.

The workshop focused on bio-structural analogies and was fashioned after my semester long studio pedagogy developed in the Department of Art, Architecture and Design at Lehigh University over the past ten years. The final results and by-products of this immersive experience were very successful and on many levels beyond our wildest expectations.



Contact:
av03@lehigh.edu

Keywords:
Bio-Structural International Design Workshop Brazil

BIO-STRUCTURAL ANALOGIES: ARMS, WINGS AND MECHANICAL THINGS

By Professor Anthony Viscardi
Lehigh University, Bethlehem, Pennsylvania, USA
av03@lehigh.edu

DESIGN WORKSHOP February 7- 16, 2012

FAUUSP: Faculty of Architecture and Urbanism, University of Sao Paulo, Brazil

Abstract

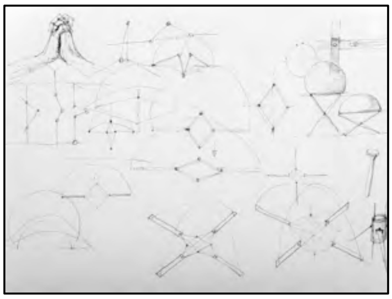
This paper is an account of the experiences and accomplishments of a 7-day intensive design workshop I conducted in collaboration with FAU (Faculty of Architecture and Urbanism) at the University of Sao Paulo, Brazil during their summer session in February 2012. Earlier in May of 2011, I was invited to conduct a series of lectures at FAUUSP after meeting several of their professors at an annual Generative Arts Conference in Milano, Italy, in December of 2010. At the GA Conference, I presented a paper on my design pedagogy that generated interest and prompted the invitation to speak at FAUUSP in the near future. During the speaking engagement at FAU, I discussed, with a small group of FAU professors, the possibility of returning to teach an intensive design workshop during the school's summer session. In collaboration with an organizing committee composed of Profa. Dra. Clice de Toledo Sanjar Mazzilli, Profa. Dra. Cibele Haddad Taralli, and Prof. Dr. Artur Simões Rozestraten, I drafted an outline and schedule to present and conduct this experimental design workshop during the month of February, 2012. The workshop will focus on bio-structural analogies and will be fashioned after my semester long studio pedagogy developed in the Department of Art, Architecture and Design at Lehigh University over the past ten years. The results and by-products of this immersive experience turned out to be very successful and on many levels beyond our wildest expectations.

Bio-Structural;,. Analogy;,. Drawing;,.

DESIGN WORKSHOP PEDAGOGY

The studio would utilize the skills of drawing both analogically and digitally to initiate their associative thinking process. Later, through model making both by hand and using the laser cutter, the students would form structural prototypes by studying systems outside of the normative building practices, but derived from nature, in order to discover alternate forms of architectonic propositions. The students finished the workshop by mostly working in small groups. This proved to be very successful in that it forced collaborative decision making and group authorship. Several of the workshop students have been encouraged to utilize their findings as a point of departure in their design studio during the following semester. The faculty at the University of Sao Paulo embraced the design workshop and saw multiple possibilities for augmenting future design curriculum in their interdisciplinary programs. Not only did this workshop succeed in what the students produced but it also acted as a platform for future discussions about design research and architectural curriculum in general.





Students doing initial drawing exercises

One of the challenges of design instruction is to establish a fertile environment for discovery and imagination, whilst grounding design work within architectural constraints. The beginning student especially has difficulty juggling the specific programmatic requirements of a studio brief, and the open-ended- ness of the design process itself. To compound this dilemma, design studios often assume the lexicon of “problem-solving”; the final design is commonly referred to as a “solution” or “answer”. When the design process is goal-oriented in the early stages, the possibilities for open exploration and imagination are curtailed. An experimental design studio that I initially conducted at Lehigh University’s Department of Art and Architecture sought to remedy this dilemma.

In order to establish the studio as a setting for wonder, research, and invention, this experimental studio/workshop emphasized the process of design inquiry. A select group of students from the undergraduate and graduate levels of Design at FAU undertook a series of intensive exercises (which were cumulative in effect) based on a series of analogical studies. Analogy was an effective device for creative invention, since parallel readings were implicit at many levels, from surface meaning to operative functioning. Analogical exploration also allowed the students to assimilate complex forms and processes from realms outside of the architectural discipline. The students were thus enabled to discover architectural form and use in a manner unencumbered by preconception and conventional program.

Using analogy in the form of design assimilation, one is positioned to rely on his or her creative ability to associate and fabricate objects that engage materials into relationships that convey parallel meanings. These constructions can, in turn, establish formal orders that become the basis for an architectural grammar of details. Their meaning is gained through their ability to conform or transform to the context in which they are placed. These construction details can also be employed as a point of departure in the development of a design process. Through an analogical study of the joints in the body, the invention of a joint detail can form the basis of an architectural vocabulary that can lead to several forms of design development.

First design review of three analogical collages

Exercise One:
Collage of Arms, Wings…

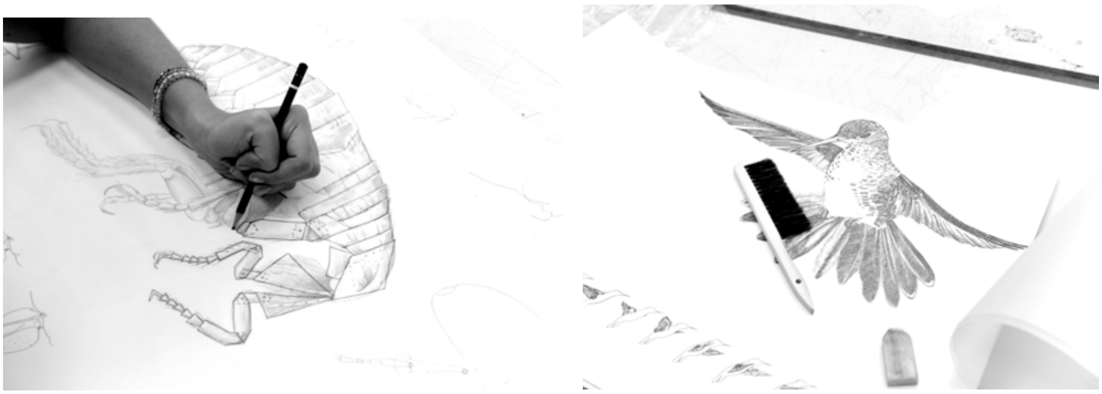
The analogue studio, therefore limited itself to the investigation of the architectural part, or detail, specifically, joints and connections. These exercises would eventually lead to specific propositions, such as, cantilevers, corbels, arches, trusses, hinges, and pivot joints. These devices were not a priori goals, but were discovered through the form-making process itself. To begin, the students observed and compared the arm of the human body and the wing of birds, bats, or insects in terms of dynamic forces accommodated by the muscles, tendons and joints of these two body forms. Several students also researched other creatures for analogical relationships such as worms, jellyfish and fleas.

… and Mechanical Things

The students then proceeded to develop a third collage of mechanical artifacts that had an affinity to the previous studies. Simple devices (such as lamp arms, car jacks, umbrellas, drawing instruments) were sought. As in the earlier collages, mechanical items were sampled from a combination of photographs, objects, drawings and words. The students concurrently observed the drawings of Leonardo da Vinci, in particular, those that simultaneously convey the analogous workings of mechanical, anatomical and architectural devices. From these drawings the students could infer the interchangeability of parts that were human, animal and mechanical — i.e. whereby one part could be the "prosthetic" of the other.

Exercise two:
Drawing Constructions / Constructing Drawings

In this process of investigation and discovery, drawing acts as a means of construction, of ideas, of images, of analysis and of association. The drawings will be viewed as scaffolding; a temporary architecture used to help concretize an idea that leaves its trace in your final construction, allowing 2-D and 3-D to collude in the process of design.



Students drawing their bio-structural analogies

observation/analysis interpretation/translation transformation/fabrication

The next phase of this series of observations begins with a detailed enlargement of a particular wing/creature scaled up at least double in scale. This means of magnification and rendering intensifies ones focus to prevent shifting attention to quickly assuring that observation will not be short-circuited into translation as mere imitation. It is more important to continue the seeing process by forcing hand/eye coordination to slow down permitting a closer look. It will allow the mind to wander generating creative associations to occur while rendering tonal gradations. This releases the daydream. It is in that zone that tangential co-incidents collude to form new interpolations of hand/mind and mind/hand thinking.

The exercise will consist of three layers: Each layer will look at a different aspect of the wing: a realistic look at the nature of its parts, a geometric abstraction and a mechanical extrapolation. Each sheet conveys a distinct view of your specimen. All sheets are pencil on Mylar except the first sheet, which is on watercolor paper stock.

observation/analysis………………as is: We began looking very close so the eye could attain a tactile sense—inhabiting the detail. After reviewing the visual collages, each student clarified a particular perspective that would direct this next phase. Students now choose an appropriate image of their wing/creature to further his/her research. Draw the wing at least twice the size of the photo to be placed in the middle of a 24x 32 piece of watercolor paper [hot press] leaving at least a 6" border on all sides for even closer studies. This first sheet is to be purely observation of the actual wing analyzing its parts through realistic close up rendering.

interpretation/translation………as ab: The next sheet is on Mylar and drawn in pencil to interpret the parts of the wing/creature in a more geometric construction. This technique requires a translation of the parts into a geometric vocabulary viewed as an overlay upon the preliminary realistic drawing. This ***abstraction*** will allow you to see the workings as interpreted through geometry.

transformation/fabrication……as ob: This final sheet of Mylar will transform the visual information into a construction analog to direct the fabrication of a series of tectonic devices…workable, buildable ***objects.*** This drawing would work in conjunction to each student's sketchbook where they would work out construction details and performance criteria.

Exercise Three:
SIMULATION VS. ANALOGY

Students and faculty talking about their models

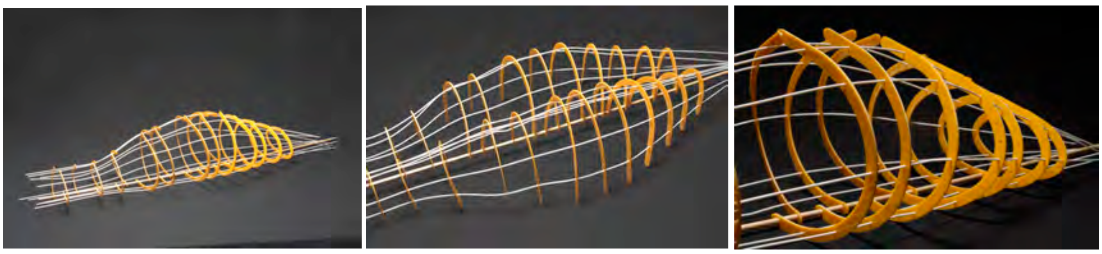
mechanical simulacrum: From the studies in Exercise Two, each student created a model, or mechanical simulacrum, that could demonstrate the dynamic actions from their previous wing analysis. These models were crafted from basswood using mechanical hardware for joints and built at a large scale (usually 1:1). Using the form language derived from the geometrical abstraction (the second layer in Exercise Two), these constructions translated the actions of the wing in its entirety. Resemblance of the model to the mechanical, (or operative) appearance of the entire wing was desirable in this model.

mechanical analogue: The students constructed the second model, or device, as a mechanical analogue to a specific part or detail of the wing analysis. It gained its potency from the nature and fit of its parts. This model did not attempt to resemble but to demonstrate metonymically the action of a particular condition. The parts could be separated from their context or viewed as a series of parts disconnected form the whole. Resemblance of the model to the original was not desirable for this model. The models were meticulously crafted, whereby each and every joint and connection acquired a distinct character. The students made additional "working drawings" in their sketchbooks, while constructing the models, whereby drawings and models informed each other in an interactive dialogue. Each model obtained an intrinsic value in relation to its function of movement and support and also acted as an initiator to new refinements and innovations.

Creative Collaboration

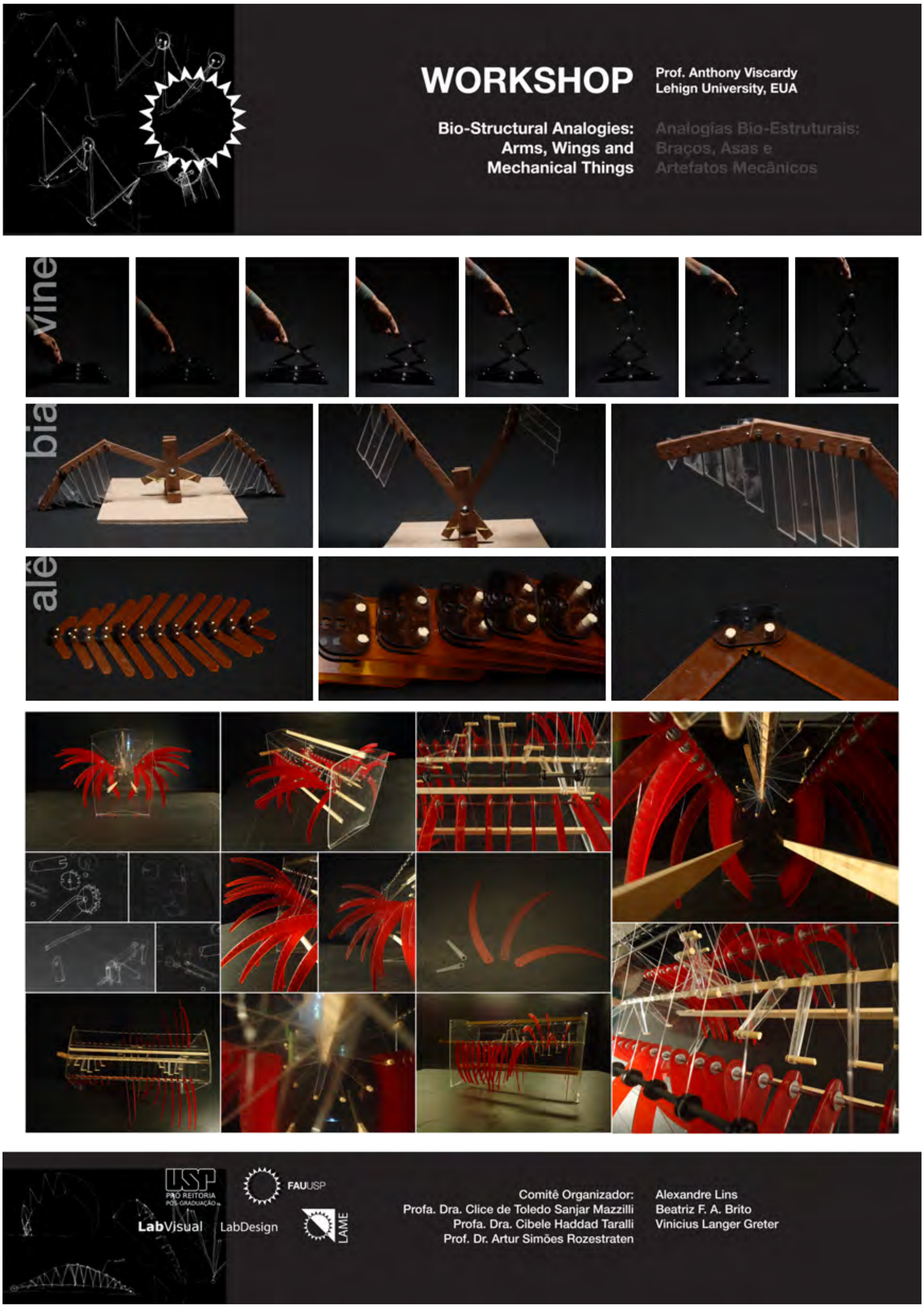
At this point of the workshop, after each student presented their simulation and analogue models, small working groups were established with models that demonstrated similar concepts, ideas and constructions. The teams were to spend the final three days to formulate new hybrid designs that demonstrated the strengths of their individual counterparts into one resolved new analogical construction. The remainder of the workshop would take place in LAME, the technical workshop laboratory at FAU as an intense and immersive design/build environment.

Natural Growth as a Generative Analog



Caterpillar analogy final models

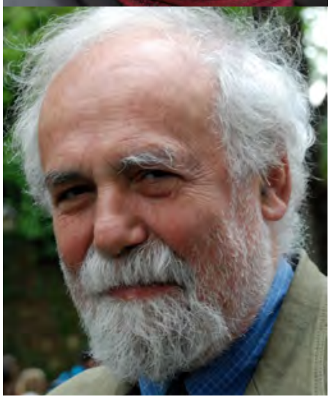
For this portion of the studio, in a reversal of ordinary studio practices, the students assumed the responsibility for determining the meaning and functions of their architectural constructs. By looking at function as a response to the manufactured artifact (rather than as the initiator of its design) the students evaluated the intrinsic properties of their invented form. Could the devices return to architectural situations that involve the action of the human arm, such as a door swing? Could their devices become roofs, walls, or both simultaneously? Could the study of natural growth patterns provide an analogous process to design development? In all things natural, growth generates form. The students were now to reconstruct a new body propagated through the multiplication of a single element of the arm or wing into an organization of parts. These parts would establish systems and ultimately networks of performative results.



Student Group Final Poster Presentation

Celestino Soddu
Enrica Colabella

Poster : **Generative Art Criteria**

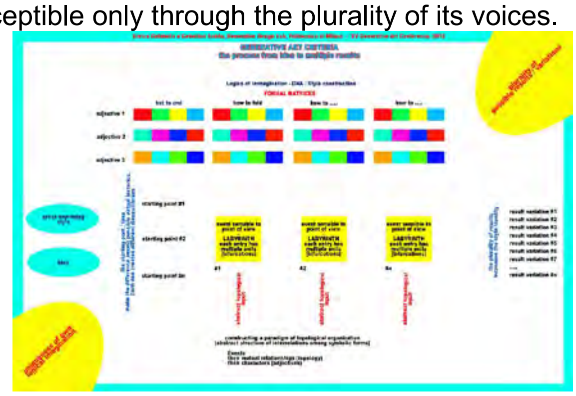


Topic: Generative Approach

Authors:
Celestino Soddu
Enrica Colabella
> Generative Art lab, Domus Argenia, Sardinia, Italy
> Generative Design Lab, Politecnico di Milano University, Italy
> www: generativedesign.com

References:
[1] C. Soddu, E.Colabella, "*Il Progetto Ambientale di Morfogenesi*", Leonardo project, 1992
[www.generativeart.com www.soddu.it

Abstract:
This poster shows mainly the criteria of Generative Art process performed by us in the book "The Environmental Design of Morphogenesis. Genetic Codes of artificial ware", 1992.
It contains only some considerations about Generative Art and about traces of paths. By following own imaginary that develops itself with the casualness and unpredictability of subjective thoughts.
But with a peculiarity: these considerations are not only theoretical considerations. In the performed GA process, each hypothesis, each possible path that is outlined and each logical approach was already operatively experimented with original software and was also the basis of our teaching activities, with very interesting results.
The Generative Art paths gave us the possibility to experiment how the subjectivity as human vision with its peculiar, contingent and casual character, can operatively coexist with the rational logics. More, it allowed us to directly put the subjective unpredictability inside the logical operative approach through a peculiar concreteness of original algorithms.
By using contemporary devices we developed again the pleasure of a scientific pre-modern approach. So we work not with an axiomatic approach but with our imagination and evaluation of multiple and amazing faceting of our world.
Generative approach has made to emerge an unexpected dynamic order as unpredictable but recognizable way to skid toward the complexity. More, it has made to emerge a time of creativity able to trace the character of infinite possible parallel tales, not linear and fascinating tales about the discovering of possible.
Also if the Generative Artworks seem to be intelligent, they are only a dynamic representation of the evolution of an human idea. They are not able, in themselves, of ideation and creativity.
Their role and contribution are, in any case, essential. Like all representation they are an irreplaceable way to enter inside the knowledge as in scientific discovers.
A Renaissance concept appears again with Generative Art: the priority of uniqueness on the equality following the thinking that the oneness of reason is perceptible only through the plurality of its voices.



Generative Art is able to trace a DNA of artificial ware by proposing a meta-approach to reality. Its representations are the results of a rational construction connected to a subjective imaginary as dynamic idea-concept.

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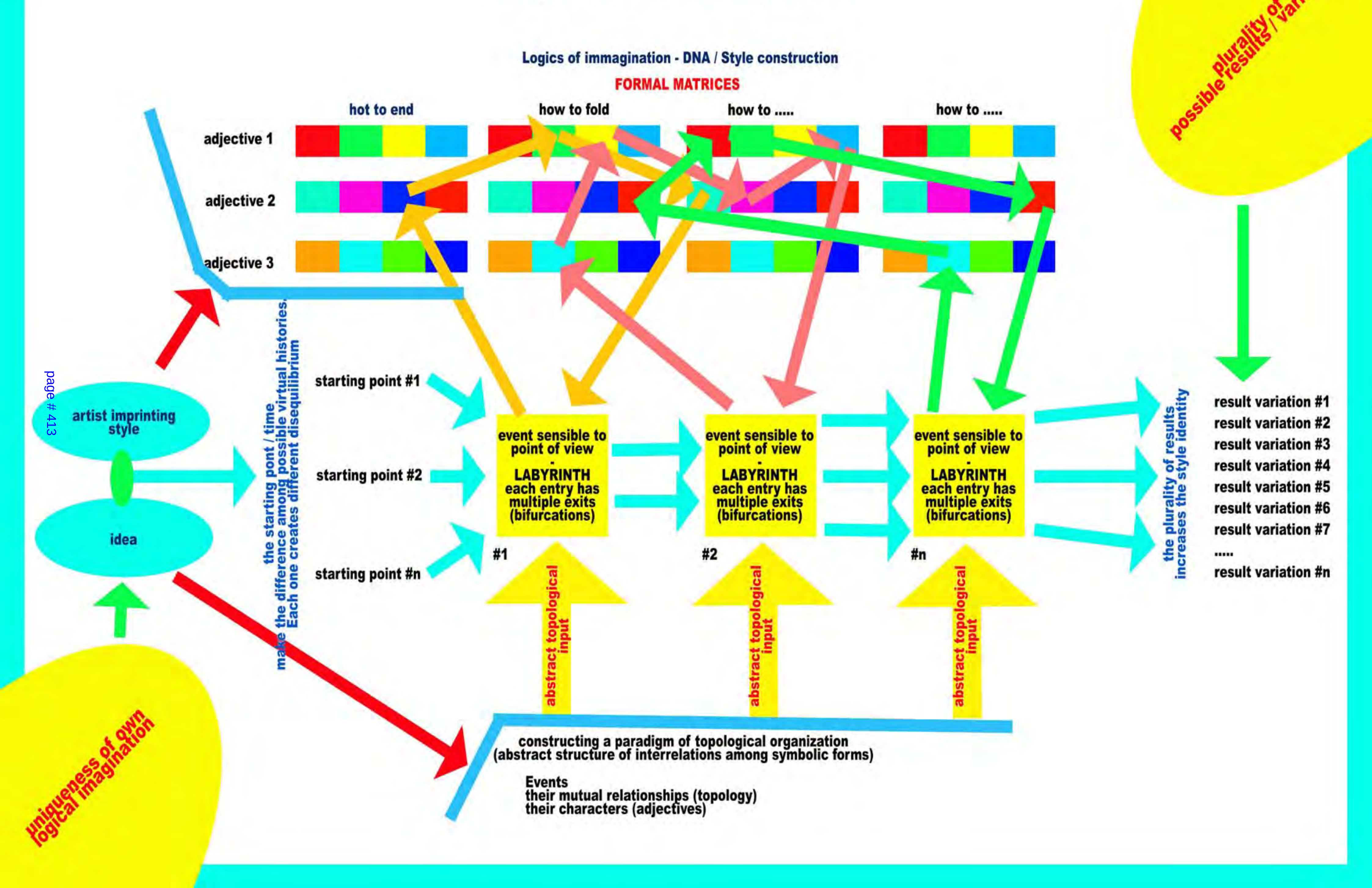
enrica.colabella@gen

Keywords:
generative art, uniqueness, logics, imagination, algorithms

GENERATIVE ART CRITERIA
the process from idea to multiple results



Ferhan KIZILTEPE

Artworks : **TWO SCULPTURES FROM INSIDE OF NONEUCLID SPACE**

Abstract:
To contribute to GA2012 artworks program with two steel sculptures is planned. The size of the each one of sculptures would be around 50cm x 50cm x 50cm. Both sculptures are representations relevant to the four types of Euclidean plane isometries (Translation, rotation, reflection and glide- reflection.These isometries that are also called rigid motions have high symmetrical character.).

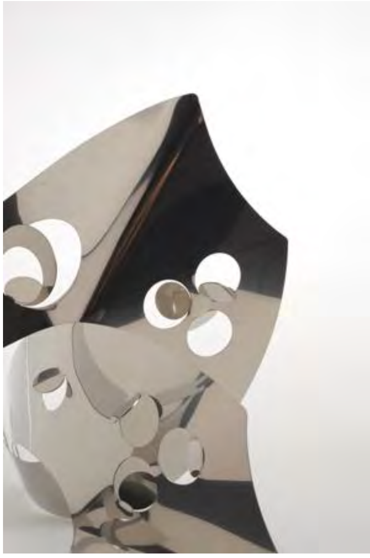
Topic: Mathematics

Authors:
Ferhan KIZILTEPE
CHD (Contemporary Sculptors Association)
www.ferhankiziltepe.com

References:

At the below; as sample there are two photos of sculptures, and a detail photo for each of them.

Nameless I



Nameless I Detail

Nameless II

Nameless II Detail

Contact:
aser@ferhankiziltepe.com

Keywords:
Symmetry, Euclidean plane isometries,

Julie Clarke

TITLE: The Body and the City

Abstract:

The Body and the City examines the relationship between the body as a site of spontaneity and change and the en-framing qualities of the city as site in which a critical understanding of this relationship is reproduced. The central theme is identity, which is fluid, changeable and developed as a dialectical relationship between self and other; the individual and the social, the subject and object. The work makes problematic the nature of identity within a social and political context that controls and produces identities, what Michel Foucault refers to as *docile bodies* in panoptic societies. I examine a tactic used by Michel de Certeau in which the individual resists imposed subjectivities of a surveillance society and of what Guy Debord refers to as the *society of the spectacle*. My photographs reveal a concern with people as ornamentation ~ decorous to the landscape, as order and disorder, an arrangement within a fixed urban environment, part of the textural interplay between building surface and body as fluid architecture. More often than not my photographs of ordinary people are about them watching or waiting for the other. The work is a DVD containing fifty-two photographs I took in 2010 of people from the city of Melbourne. These images are interspersed with a poem I'd written and accompanied by a soundtrack of ambient sounds I collected from within Melbourne business district, which were remixed into a sound design by my son. The artwork may be exhibited/installed on a monitor or projected onto a white wall. It runs for approximately 5-7 minutes and may be placed on a continuous loop. **If accepted for installation I can post the DVD to you.**

Example of part of the poem:

That's what it does
It makes everything bleed out
No odour, No touch, No sound
Everything silent, as though
One's eyes flicker and are, then still.

Topic:

Art/poetic text/music

Authors:

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Hawthorn East,
Victoria, Australia 3123

Sound design: Erin Powell

Contact:
jjclarke@unimelb.edu.au

Keywords:
Body, city, identity, difference, ornamentation

LAURENCE GARTEL

TITLE: GARTEL ART CARS

Topic: ART CARS

Author:
LAURENCE GARTEL
Digital Media Pioneer

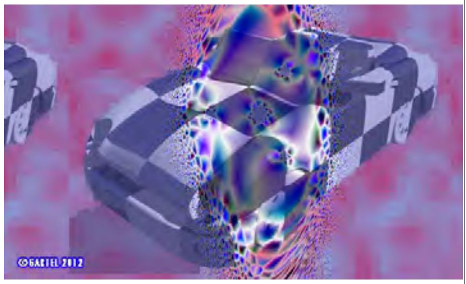
www.gartelmuseum.weebly.com

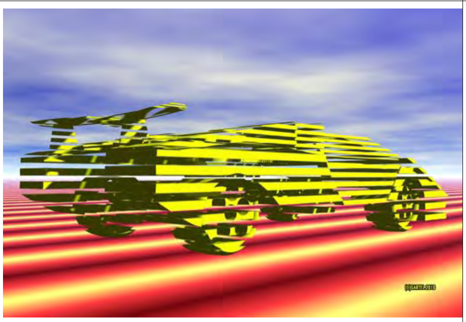
References:
"*GARTEL: Arte e Tecnologia*", Published by Edizioni Mazzotta, Milan, Italy, 1998

Abstract:

For over 35-years Mr. Gartel has been pioneering Digital Media Art. He started working with analog system computers in the mid 70s with video guru Nam June Paik at Media Study/Buffalo in upstate New York. There he photographed still images created on video monitors with a camera on a tripod attempting to catch the illusive image that had refresh signals entering the screen. His notion was to capture a "moment in time" and have an electronic image replace painting as an aesthetic. This was an unfamiliar concept in the seventies, as the personal computer did not exist.

Cars were always a subject matter for Gartel as it represented time and place in our pop culture. Today through custom software Gartel continues his manipulations and creations of automobiles. They still resonate a unique aesthetic though the technology allows for far advanced imaging. It is like bringing the future into the now projecting what is to come. There is both surrealism and a science fiction sensibility about these new works. If we are to be in the present, we always focus on the future, as mankind evolves. Masters of any medium have stood the test of time. Their works project timelessness while being in the now. It's a metaphor to where we are going. Only an Artist can show us our destiny.





"Red Glass" © GARTEL 2011
"Portal" © GARTEL 2012
"Stripped Lamborghini" © GARTEL 2010

Contact:
gartel@aol.com

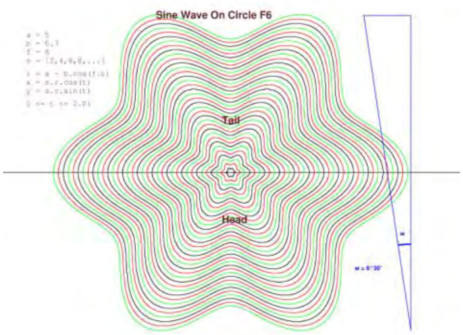
Keywords:
Digital Art, computer art, cars, automobiles, autos, 3D Art,

Massimo Gasperini

Spirals from a board

Abstract:
”Bowl from a board” is an old technique used by woodworkers: you cut concentric circles on a wooden board at a bevel angle, and stacking them up you get a bowl. Remarkably, if you use wedges instead of boards you get a logarithmic spiral.

I have written software to draw the outlines of the segments to be cut on the wedge. These segments are not only circles, but ellipses and more complicate curves like sine curves and fourth grade functions.



Changing the parameters of the curves and the angle of the wedge you obtain countless 3D surfaces. My wood sculptures are just sections of these surfaces, which can have negative or positive curvatures.

I use different kinds of wood: oak, cherry, linden, wengé, afrormosia.

Topic: Art

Authors:
Massimo Gasperini

www.despiramirabilis.com

Keywords: logarithmic spiral, wood sculpture, mathematical art

Contact: massimo.gasperini@libero.it

MEHRDAD GAROUSI

Artwork: **Let Me Go**

Topic: 3D Fractal Animation

Author:
Mehrdad Garousi
Freelance fractal artist
Iran
http://mehrdadart.deviantart.com

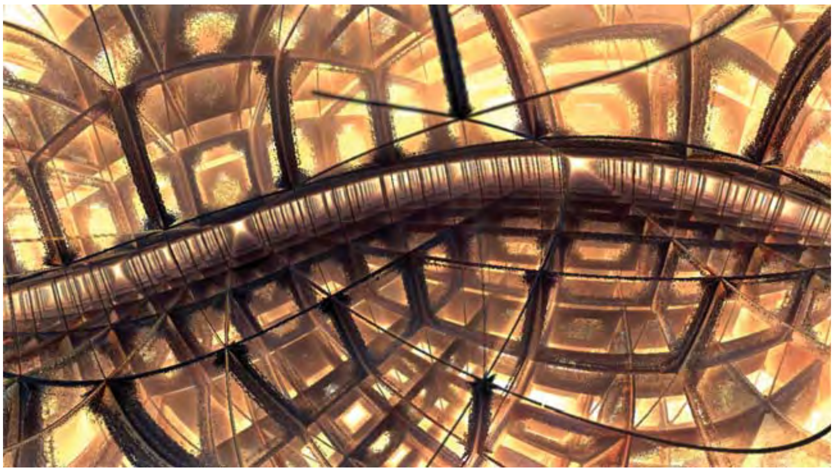
References:
[1] http://www.mixcloud.com/flinch/

[2] Mandelbulb3D, http://www.fractalforums.com/mandelbulb-3d/

[3] 2012 One-Night Film Fest, 2012 Bridges Conference, July 25-29, 2012 , Towson University, Maryland, USA.

Abstract:
This music video is a pure fractal animation made for *Flinch* [1], who is an electronic musician from North America. It is made in one of the well-known and still-under-evolution fractal programs *Mandelbulb3D* [2], except for minor post-render adjustments in *Adobe Premiere*. The animation is altogether a combination of 4 basic fractal formulas and what is seen during the 5:45 of the play is the result of variations in the constructing numeric variables defining these formulas or those controlling environmental phenomena like colors, lights, etc. Fractals are very modern results of fractal geometry which introduce us to very strange worlds belonging to fractional dimensions, resembling the unconscious digitally. Fractals are materialization of numbers in form of complex but controllable systems. Two of the best known techniques in fractal animating are magnification and the morphing of shapes and environments which could be seen in this animation as well. Morphing struggles with the constructing numeric relations defining the digital world around before our eyes in fast continuous processes. This fractal animation, on the whole, was a direct interaction between codes, numbers, equations, adjusters, and computer on one side and my ears, listening to and interpreting the music, and my mind, traveling within the complexity of the aesthetics of digitality and fractality, on the other side.
Non-stop rendering of the final version of this 5:45 animation at 1280 x 720 pixels took my hexa-core cpu more than two weeks.
This animation was presented at 2012 Bridges One-Night Film Festival and the foregoing explanation is also the same explanation presented in the Bridges film catalog [3].

Animation can be watched at:
http://www.youtube.com/watch?v=KugjZHS5ayY



A still frame of the animation.

Contact:
mehrdad_fractal@yahoo.com

Keywords:
Fractal art, 3D fractal, animation, Mandelbulb3D, mathematical music video

Peter Beyls

Installation

PETRI

Topic: Installation

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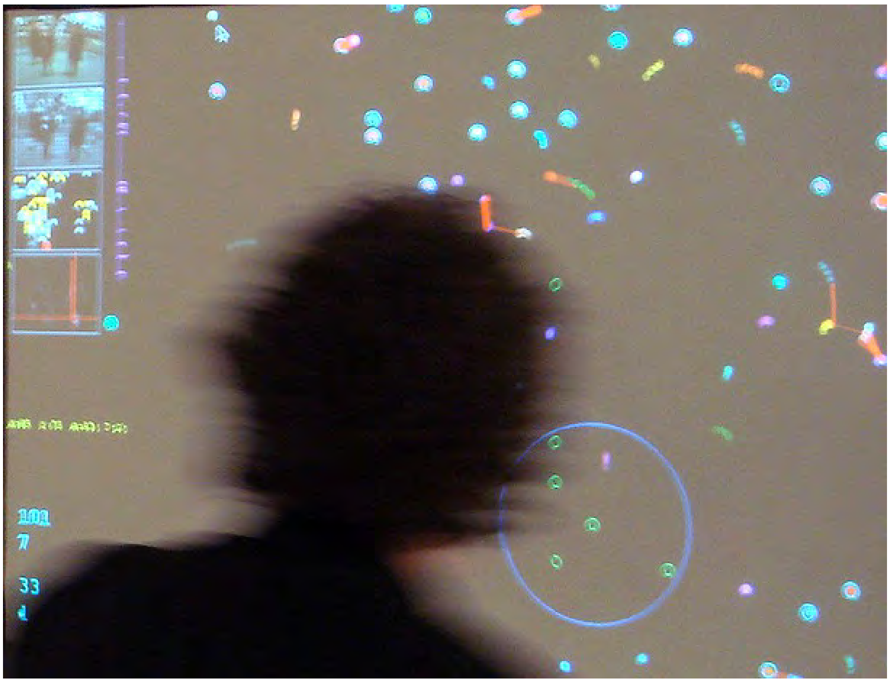
LUCA, Brussels
Belgium
www.hogent.be
www.luca-arts.be

References:
www.beyls.org

Abstract:
The present work expresses faith in the idea that rewarding human-machine interaction may emerge from the articulation of human originated *influence* over an otherwise autonomous process. It views spontaneous bodily behavior of a human interactor as complementary to the internal behavior of an artificial world. This parallel, synthetic universe is thought of as a distributed system consisting of a population of basic entities called particles. Particles interact locally using very simple rules. However, when considering the population as undivided, simple local interactions give rise to interesting, complex global behavior that could not be anticipated by the systems designer – *emergence* is said to happen implicitly without the need for global explicit human-engineered guidelines. Petri takes its name from the shallow Petri cell culture dish commonly used in the field of microbiology. Petri reveals itself as a window on a complex dynamic universe that is self-sustaining and in perpetual flux. Human interactors may develop a degree of sensitivity and fractional understanding of what is actually happening inside a population of interacting particles. However, they may never really develop a complete understanding of the installation in its entirety; a particular mix of meaning and mystery acts as a source sustaining *rewarding* machine mediated aesthetic experiences.



Petri, an interactive audio-visual installation.

Contact:
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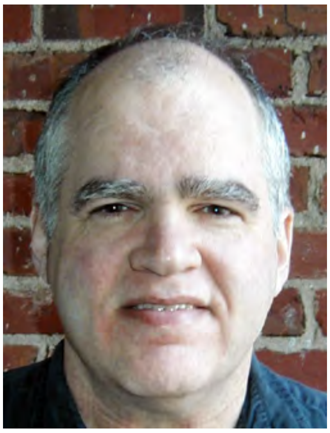
Keywords:
Interaction, artificial life, computer vision, emergence

Philip Galanter

Artwork: **TSP Analytics: solver**



Abstract:
TSP Analytics refers to a series of computer animations that explore and demonstrate emergent form generated by solving the classic Travelling Salesman Problem in optimization theory. This piece, "solver," provides a visual explanation of the problem, the process, and the relentlessly consistent form exhibited in the solution path including figure/ground reversal, some correlation of angle to attached lengths, and particularly the lack of crossed lines.

Random points within different geometric outlines (circles, squares, triangles, and hexagons) are connected, with each point being visited once and only once. Initially the connections are random. Finding the solution is depicted by uncrossing pairs of lines until no further crossed lines remain. This is actually not a good way to solve the TSP, but it is a good way to explain the nature of the challenge.

Topic: Fine Art

Authors:
Philip Galanter
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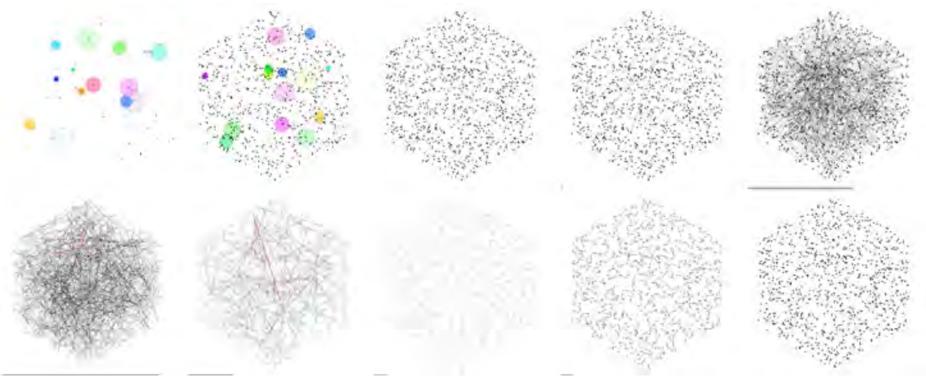
http://www.viz.tamu.edu/



Frames from one full cycle. The piece cycles continually with different outline shapes.

References:
[1] Galanter, Philip. 2004. What is Emergence? Generative murals as experiments in the philosophy of complexity. In International Conference on Generative Art. Milan, Italy: Generative Design Lab, Milan Polytechnic.
[2] http://philipgalanter.com

Please Note Regarding Installation: I will bring everything needed. The setup is quite small. All that is required is about a meter of white wall space and reduced lighting. The image will be projected on the wall using a palm-sized projector on a tripod. A similarly very small computer will drive the projector and run the software.

Contact:
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Keywords:
Animation, generative graphics, emergence, optimization

Shih-Ting Tsai

Artworks: **The Interior**

Abstract:
This visual art work is created by radiography and after editing technology. Radiography is using medical x-ray and DR system, DR means "Digital Radiography". The material of this work is including: Lily flower, medical x-ray, DR system, medical contrast fluid, x-ray film and digital photography editing program.

Method:
A distinguishing characteristic of this work, it is that we use contrast fluid and it can go through whole flower, after that, the energy of medical x-ray can be absorbed by contrast fluid, it is because that contrast fluid is high density, and other energy still goes through the lily flower, then it is projected on x-ray film.

Result & Discussion:
Another important part in this work is using digital photography editing program. X-ray work is quite unusual, however, it could only see the single colour, go through the digital photography editing, the work is going to present and create more different sense.

May this visual work could provide designers and artists with some new ideas and further impressions.

Artworks: The interior

Topic: Visual Art

Authors:
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Ming-Hsiu Mia Chen
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References:
[1] Home page of XFUNS.com, "*XFUNS*", viewed 22 Aug 2010, http://www.xfuns.com/index.php

[2] Nick Veasey, "*Biography",*GUYHEPNER, viewed 22 Aug 2010, http://www.guyhepner.com/artists/nick-veasey

[3]www.nickveasey.com/

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Keywords:
Digital Photography Editing Program, Radiography, X-ray

Tatsuo Unemi

Installation: **A fully automated evolutionary art**

Topic: Audio visual installation

Authors:
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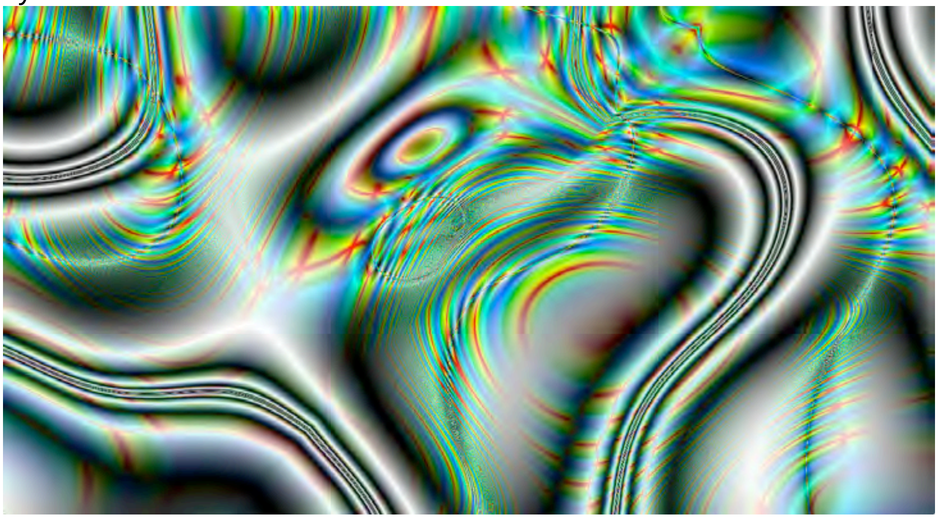
www.intlab.soka.ac.jp/~unemi/

References:
[1] Tatsuo Unemi, "*SBArt4 as Automatic Art and Live Performance Tool*", GA 2011 – XIV Generative Art Conference, Rome, 2011.
[2] Karl Sims, "Primordial Dance", Animation Video, MIT, Media Laboratory, 1991.

Abstract:
This is an installation of an automatic art that the computer autonomously produces a sequence of audio-visual effects in real time on site. A custom software, SBArt4 [1], developed by the author is taking a main role of the work based on a genetic algorithm utilizing computational aesthetic measures as the fitness function. It starts from a population of random genotypes, and the evolutionary process proceeds through opening hours. Each of individual genotypes is a mathematical expression that determines a colour of pixels in a frame image of animation, in a similar style of "Primordial Dance" by Karl Sims [2]. A never-ending series of abstract animations are continuously displayed on the screen with synchronized sound effect by picking up individuals of higher fitness from the evolving population. The visitors will notice the recent progress of the power of computer technology and also will possibly be given an occasion to think what the artistic creativity is. These technologies are useful not only to build up a system that makes unpredictable interesting phenomena but also to provide an occasion for people to reconsider how we should relate to the artefacts around us. We know the nature is complex and often unpredictable. However we, people in the modern democratic society, tend to assume that artificial systems should be under our control and there must be some person who takes responsibility on the both intended and unintended effects. The author hopes the visitors will notice that it is difficult to keep some of the complex wild artefacts under our control, and will learn how we can enjoy with them.
The system uses two mac minis, a projector, and a stereo speaker system.



Sample screen shot.

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Keywords:
Evolutionary computation, abstract animation, automatic art

Dai Juren/Li Dezhao

Parametric design in representation of culture

Topic: Architecture

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Li Dezhao
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References:
[1]
Neil leach, Rethinking architecture, Spon Press, US, 1997
[2]
Neil Leach, Digital Tectonics, Academy Press, US, 2004
[3]
www.generativeart.com

This project was part 020139 coursework led by Dr. Quinsan Ciao, Tongji Univeristy

Abstract:
This article aims to explore the prospect of parametric design in current architecture design, especially in the field of representation of culture. Recent years have witnessed that many architects successfully relate their projects with the local culture, but the methods used are viewed as monotonous by many critcis. Therefore with the emergence of parametric design, we need to conceive that what influence this booming parametric design could contribute to the long-standing practice of regionalism works. Paradoxically, parametric design is considered as an objective design approach based on specific parameters, which lacks the interaction with the surrounding environment. However we think that parametric design might be a potential tool to achieve diverse cultural meaning in architecture.
This article refers to our two design projects using parametric design. During the first design of a tea pavilion, we endeavored to convey the image or feeling of traditional tea culture in our architectural design, and this transition between our initial concept and the final project is realized by parametric design methods such as grashopper plug-ins. When compared with traditional design methods such as model making, parametric design provides us with more options of design developments, and it enables us to try more approaches within limited time. However this new design method cannot convey the cultural meaning as gently and naturally as traditional design methods. Since parametric design is processed in computer, designers are deprived of the chance to feel the actual dimension or atmosphere of architectural model, which are the foundation of our understanding of culture in architecture.
But during the second project which is a highrise design in Jinxiang area, parametric design becomes a suitable tool to reflect culture since it is used to represent an object which is already existing. Due to its advanced capacity of shape handling, it could be an appropriate tool in actualizing the image of an object, but it still lacks the capacity to represent phenomenological feelings. Therefore we come to this conclusion that parametric design cannot replace the role of traditional design methods in the field of representation of culture in architecture at present. It is, nonetheless, a tool with great implications for cultural architecture, as we seek to demonstrate in this paper.

concept of tea pavilion

source of the concept of second project

Contact:
julien_dai@hotmail.com

Keywords:
Parametric, Architecture, Regionalism, Glocalization, Post-modernism, Culture, Pavilion, China

The prospect of generative arts on cultural representation

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Premise:

This article aims to explore the prospect of parametric design in current architecture design, especially in the field of representation of culture.

Recent years have witnessed that many architects successfully relate their projects with the local culture, but the methods used are viewed as monotonous by many critics. Therefore with the emergence of parametric design, we need to conceive that what influence this booming parametric design could contribute to the long-standing practice of regionalism works. Paradoxically, parametric design is considered as an objective design approach based on specific parameters, which lacks the interaction with the surrounding environment. However we think that parametric design might be a potential tool to achieve diverse cultural meaning in architecture.

This article refers to our two design projects using parametric design. During the first design of a tea pavilion, we endeavored to convey the image or feeling of traditional tea culture in our architectural design, and this transition between our initial concept and the final is realized by parametric design methods such as grasshopper plug-ins. When compared with traditional design methods such as model making, parametric design provides us with more options of design developments, and it enables us to try more approaches within limited time. However this new design method cannot convey the cultural meaning as gently and naturally as traditional design methods. Since parametric design is processed in computer, designers are deprived of the chance to feel the actual dimension or atmosphere of architectural model, which are the foundation of our understanding of culture in architecture.

But during the second project which is a high-rise design in Jinxiang area, parametric design becomes a suitable tool to reflect culture since it is used to represent an object which already exists. Due to its advanced capacity of shape handling, it could be an appropriate tool in actualizing the image of an object, but it still lacks the capacity to represent phenomenological feelings. Therefore we come to this conclusion that parametric design cannot replace the role of traditional design methods in the field of representation of culture in architecture at present. It is, nonetheless, a tool with great implications for cultural architecture, as we seek to demonstrate in this paper.

Acknowledgement:

This article is under guidance of Dr. Quinsan Ciao, and the project was part coursework led by Dr. Quinsan Ciao, Tongji University.

Culture background in Architectural design

As students majoring in architecture, too often we create the stage upon which the drama of life unfolds, without really understanding the purpose of the play. Therefore when we were given the task to design a tea pavilion, we may be predisposed to take the time to explore the projects laterally, to contemplate a while on how we might embrace a new design paradigm wholeheartedly such as parametric design.

Recent years have witnessed that many architects successfully relate their projects with the local culture, but the methods used are often viewed as monotonous by many critics. There are many reasons that result in this phenomenon. Admittedly, it is true that we live in more fragmented times than ever before. Unlike Greek temples or Gothic cathedrals, contemporary buildings might look like anything, because they are not driven by beliefs, ritual, dogma or political certainties that nurture or drive them into particular forms, plans, sections and ways of commanding attention. The obsession on appearance becomes a great challenge for architects as well as a potentially growing risk for our society in the foreseeable future. In this article, we are not trying to refute the current situation, and what we are seeking for is a new solution to develop buildings that are seamless works of art, technology and science that, at the same time, are truly humane. This requires architects to look deeply into the culture where architectures locate, and endeavour to integrate the culture with function required by clients. Actually during the recent decades, a number of local Chinese architects have contributed a lot in the exploration on how to reflect regional culture in architectural design for the time being. And the following cases are among one of the best, as we think.

NingBo Museum

-Texture

Ningbo museum is the representative work of Wang Shu, who is one of the most prestigious architects in China. He is famous for his research of representing Chinese culture through modern architecture language, which also gives us a lot of inspiration. The museum provides us the unique way of showing the culture of Zhejiang region, which is located in the eastern coast of China.

The exterior decorations of Ningbo Museum are made in two ways. Walls are decorated by millions of tiles recollected from local areas, where many old dwellings have been wiped out and left huge amount of tiles to be piled up.

This kind of decoration itself is a common way of building an economical house in ancient days in Ningbo when cements are not introduced. Other walls are decorated with cement-covered bamboos. It is reported that Ningbo Museum is the first museum built with large number of used materials. And in the following works of Wangshu, we could also see the similar method employed such as Ningbo Tengtou Pavilion in Shanghai World Expo.



2010 China Pavilion in the world expo

- symbol

As the Chinese national museum of Expo 2010, China Pavilion embodies Chinese culture in various ways.

The 69.9-metre high pavilion, the tallest structure at the Expo, is dubbed "The Oriental Crown" because of its resemblance to an ancient Chinese crown. It was meticulously designed with profound meaning and symbolism. The architectonic feature of the building was inspired by the Chinese roof bracket known as the dougong as well as the Chinese ding vessel. The ‘dougong’ is a traditional wooden bracket used to support large overhanging eaves which dates back nearly 2,000 years. It symbolizes the unique charm of Chinese architecture and the unity and strength.

The main façade is similar to the Chinese character “Hua”, which means China in Chinese. Such imitation can be distinguished by common people easily. Besides, as we all know, red is a widely used color in China, which makes a happy atmosphere in the site. When visitors step into the site, they would get the idea easily that they are in China Pavilion.

Suzhou Museum

-spatial hierarchy

The current building of Suzhou Museum was designed by Pritzker Prize-winning Chinese-American architect Ieoh Ming Pei in association with Pei Partnership Architects. Construction of this building started in 2002. It was inaugurated on October 6, 2006.

Different from Ningbo museum, Suzhou museum reflect the culture in Jiangzhe region both in the volume and proportion of architecture. This museum is combined with the traditional architecture features, placing the museum in yards, which is an excellent way to coordinate with environment. When visitors stepping around the exhibition, they would going through spaces of different sizes, the huge public space and small private space. Such rhythm in space would represent the characteristics of tradition Jiangzhe dwelling.


Our design

-tea pavilion

Recently, we participate in a school project led by Professor Ciao which aims to design a tea pavilion within an area of twelve square meters. The core requirement of this project asks the participants to reflect the spirit of Chinese tea culture by design. This task calls for the understanding of Chinese traditional culture as well as the basic ability to deal with a logical architecture. For us, we have to reach the balance between the essence of culture and the logic of architecture, and this difficulty in building the harmonious relationship between the tea pavilion we design and the culture the pavilion reflects pushes us to think deeply on how our modern design of architecture could satisfy the needs of the project as well as convey the culture where the architecture locates. Once, Ludwig Mies Van de Rohe suggested that architecture was the will of the epoch translated into space. More prosaically, and no less wisely, he also said architecture existed when two bricks were put together well. His definitions are complementary rather than contradictory. This giant of early Modernism was right, yet only partially, as I'm sure he knew. Since architecture, although a cultural continuum stretching back to the first temple complexes of ancient Mesopotamia, is an art, a discipline, a way of seeing and ordering the human experience, that continues to change. Led by this principle, we strive to feel the culture reflected by the tea pavilion.

Paradoxically, we seem to be familiar with the Chinese tea culture at first, but when we try to realize the culture in our architectural design, we came across a dilemma. The tea culture involves complicated rituals and the variety between different areas. It's hard to choose one or two characteristics which could represent the Chinese tea culture explicitly. What we need is something which can be realized in our architectural design, and this must be identifiable to the majority.

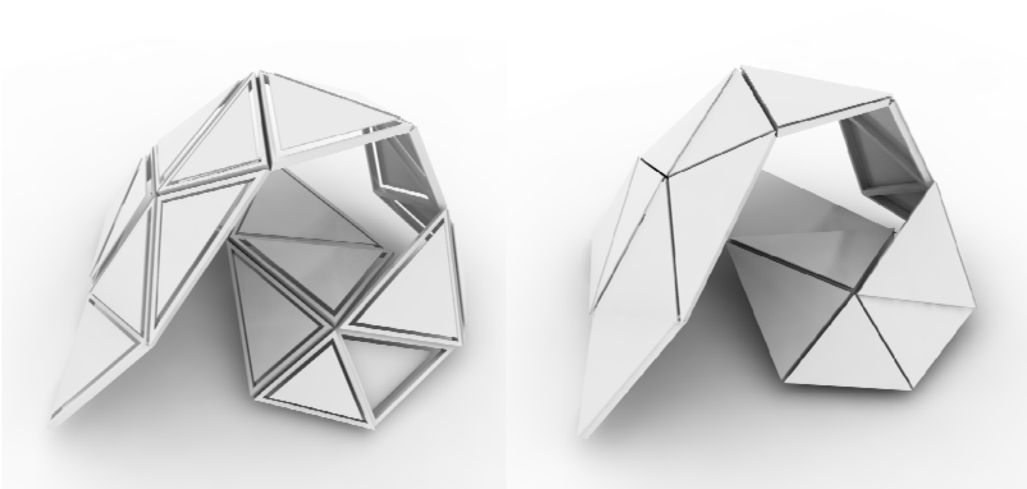
Then, we try to extract the indispensable elements of Chinese tea culture. We carry on a thorough analysis on tea culture, and we find out later that there is a close connection between Chinese Confucian culture and tea culture, those elements in common could remind us with the impression of Chinese traditional culture. What matters most is the site where the tea ceremony is held, and such representation of these traditional tea ritual sites impresses the viewers, and we believe that by representing these sites, we could arouse in the users of tea pavilion the impression of traditional tea culture.

We conclude the two most distinctive elements in both cultures: rocks and trees. In traditional Chinese paintings, rocks are always displayed as the site where scholars taste tea and share ideas with each other. These natural rocks in the painting are believed to be a symbol of freedom and the purse to become a part of the nature. Trees are not only the natural object but also the embodiment of a person. Also, trees play an important role in tea culture, and those scenes which people taste tea, sitting under trees are quite common in traditional Chinese paintings which depict tea culture. Therefore, we try to apply these two crucial elements of tea culture to our design of tea pavilion. Later we focus on the conceptual model and try to work out a solution to represent our ideas.

Undoubtedly, making concept model is an important process which helps us to capture the essence of Chinese tea culture when we advance our design. During the process of making concept model, we try to be emotional in dealing with the shape of architecture. We try different materials and structures to explore the best way to represent the culture in architecture, and during this process, we do not simply imitate the shape of trees or rocks. On the contrary, what we focus on is to explore the appropriate way to represent culture accurately.

We make several models, and we continuously improve it according to our prospect. Such exploration gradually develops into the clue for our further design. Also more importantly, we came to realize that some solutions such as parametric design other than hand-made models are more appropriate for this design since it provides more possibilities to try varied approaches, and parametric design could become an ideal testing ground in our exploration of culture representation.

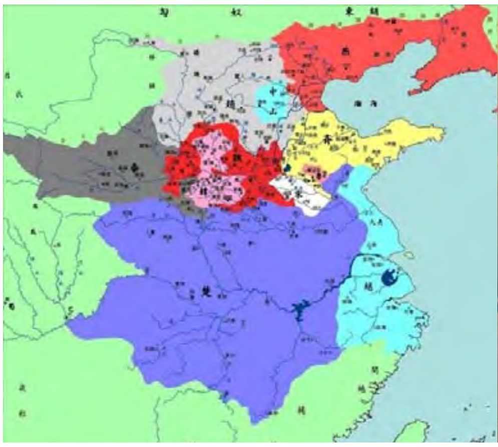
We realize it's important to convert the concept to a real architecture. And we try the parametric ways to develop our design based on the concept before. We try various approaches to explore the tea culture in each design, and then evaluate whether the tea pavilions convey the tea culture elements appropriately. After several approaches, we decide on the repetition of folding plates, and such means try to arouse in the visitors the impression of rocks. In additional, two comparatively large tree-like structures are installed so as to sustain the weight of these folding plates. With the application of parametric design, we were able to work out the final project, and it also shows the complexity and accuracy which is an obvious advantage resulted from parametric design. However, we may not achieve the prior expectation to reflect the traditional tea culture simply but straightforward.



Our design

-urban design *in jingxiang area*

Later on, we also work on another project which is an urban design in Jingxiang area. And the design base is located in the central part of China and by the side of Han River, which is an important branch of Yangtze River. From the spring and autumn Period, about 2,500 years before, Jingxiang region has been cultivated and the prosperity of local culture had lasted for a long time. This region has been the treading hub benefit from the transport capacity of Han River and Yangtze River.

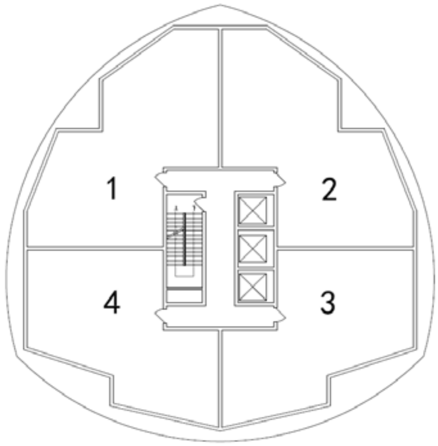


Developers of this project want to create these architectural landscapes of the whole base which would carry its function as well as a landmark which transforms this area. It is important for designers to reflect local culture, and the feeling of history is what they seek for.

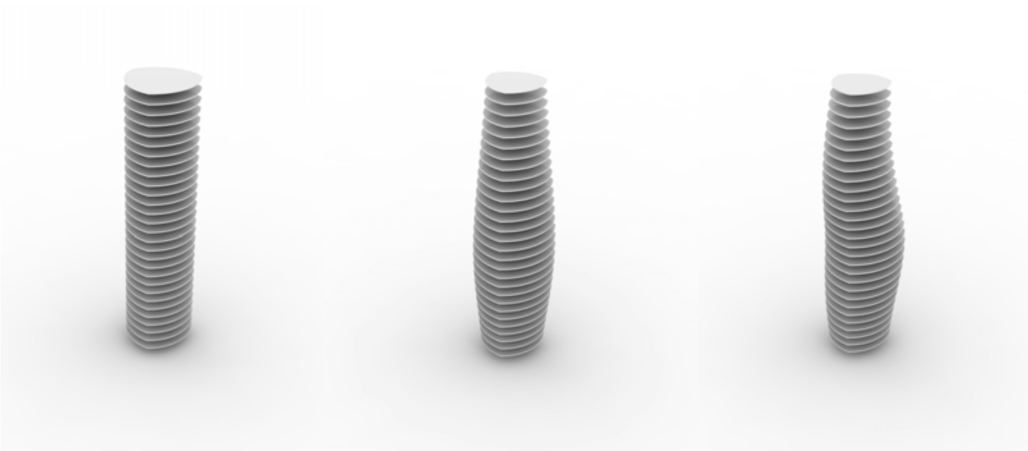
Our design initiates with the extraction of cultural elements. Since ancient times, china has been the core of Chinese and foreign trade, and it is also the symbol of highly developed handicraft industry in ancient China. As the trading hub of central China, JingXiang region is famous for its china and many newly discovered wares which were buried under ground have shown us the beauty of china again. As a consequence, we use the material china as the symbol of their local culture. Glittering and translucent carving china shows us the highly developed handicraft and their graceful curve has some connection with the rivers in JingXiang region.

In order to identify the symbol of culture, we try to realize this idea through parametric method, and the first step is to determine the form of parametric unit. By repeating such unit, we can make the whole architect design.

In the progress of choosing unit, we cast off the form of circle outline which is common in the imitation of the material china. Similarly, we use a combination of the triangle and the round, not only with the edges and corners of triangle, but also with round boundary of circle. When compared with the pure round, such parametric unit has its own direction. In the progress of large combination, this unit can provide us a changing rhythm of the whole building, which is more beneficial to a changeable design and reflection of culture.



In the following step, we integrate the smooth curve of the material china with our design. When we repeat such parametric units, the unit is changing with the parameter chosen from selected curve. By using these parameters, the units are scaled to realize the curve outline of building and their centers are moved to make the building more graceful.



Also, by changing the curve from which we get the parameters, we get different kinds of single building, and all of these are combined together with the use of the former parametric unit. Based on this principle, we came closer to the final result.

In this design, we make effort to reflect the local culture by the method of parametric generating design. With the means of repeating parametric unit, we tried to represent the cultural symbol that we picked up from history and culture.

And the final result turns out to be a success, and the image of our projects is conceived to convey the impression of the material China gently and smoothly

Conclusion

By comparing and evaluating these two projects, we may easily tell the advantages brought about by the parametric design. Apparently, it provides us with more opportunities to realize our initial conception, and its potential is still to be developed. Due to its advanced capacity of shape handling, it could be an appropriate tool in actualizing the image of an object, but it still lacks the capacity to represent phenomenological feelings. Therefore we come to this conclusion that parametric design cannot replace the role of traditional design methods in the field of representation of culture in architecture at present. It is, nonetheless, a tool with great implications for cultural architecture, as we seek to demonstrate in this paper.

Reference:

[1] Christian Norberg-Schultz, ‘The Meaning in Western Architecture’, architectural press
[2] Kenneth Frampton, ‘Modern Architecture: A Critical History’, MIT press
[3] I.M. Pei, ‘Building China Modern’. PBS. Retrieved 2 August 2012
[4] Jun Li, Yiji Cao, Ningbo Museum: made by used materials
[5] "Introduction of Pavilions at 2010 Shanghai World Expo - China Pavilion".
[6] Daxia Li, Computational Construction
[7] Neil leach, Rethinking architecture, Spon Press, US, 1997
[8] Neil Leach, Digital Tectonics, Academy Press, US, 2004

LIVE PERFORMANCES

Mr Badu Evans

TITLE: *Heritage Inheritance and Diversified Cultural Value*

Topic: *Heritage Inheritance and Diversified Cultural Value*

Authors:

Mr Badu Evans

Amamere Concepts Limited Box AT 2209,Achimota Mk Accra

http://amamerefomdaensemble.ning.com

The acrobat display of The Central Region

Abstract:
Since the beginning of stone age, regeneration and heredity has played a vital role in our societal lineage.
The variations of our cultures have made it very important to know where one comes from. The use of marks on the face, drilling of nasal cavity and fill with iron rods, etc.

Many of these type of ancient practices were abolished through 18th century towards 19th century, now in our World, we put these on stage to showcase these tradition that depicts one race from another, as we normally say, YOUR LINEAGE IS WHERE YOU BELONGE,EAST WEST,NORTH AND SOUTH, home is the best.

We will show you the transitions of African culture from the stone age to the modern day; join us on this journey……..

Image of Northern Herdsman

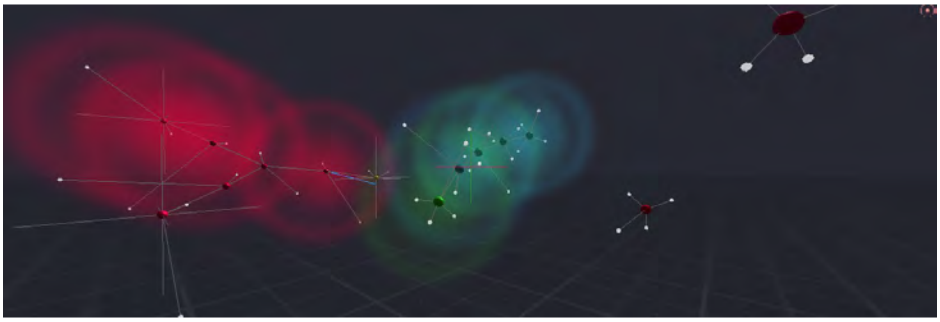
Amamere Group Members.

Contact E-mail:
evansinging@gmail.com

Keywords:
One, two, three, four, five, six, seven

Davy Grégoire

Live performance: **BIPMAT 3.1**



Topic:
Audiovisual performance

Composer:
Davy Grégoire

Bipmat is a musical interface consists of physical objects based on atom's behaviors. Basically, a sound particle is made of a core (sound source) interacting with one or more electrons (musical event).

The possibility to arrange several particles in order to generate sound synthesis or play musical sequences leads us to consider the matter idea like a dynamic partition, made up of heterogeneous elements, more or less autonomous, in which the user can navigate freely.

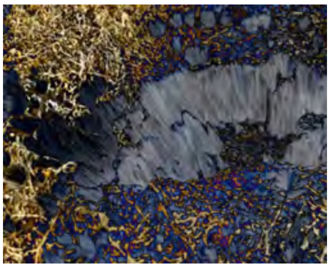
The sound synthesis is at the same time led by user interactions(midi control) and generated by dynamics properties of an object (string, branching,membran...), as well as disturbed by external events.

Contact:
contact@spinzero.org

Keywords:
Electronic music,sound matter

INIRE

Live Performance: **shipwreck score**



INIRE is an open project, composed by artists working on the mutimedial and experimental art fields. The most important audiovisual projects realized since year of it's creation (2001) are: „,,Hermetic Garden" (2001), "Septem Sermones ad Mortuos" (2004), ,,Traces" (2007), „Atalanta Fugiens" (2009), „Dante's Songs", „chopintimacy" (2010), „Dante's Songs 2.011" and „re-membering re-called" (2011) which fluctuated between philosophy, art history, structures of myths and communication theory, using new media ways of expression.

Performance *shipwreck score* is composed of three independent interpenetrating levels: sounds, texts and video. Important element of it's construction is spoken language, singing and melodeclamations, which mix thorouhgly electronic world with natural human expression.

Sounds and pictures of shipwreck remains collected during documentations on eastern coast of Iceland were used here to construct the structure of recordings, electroacoustic elements and generated audio and visual datas. Performance includes elements of reception and deconstruction of natural phenomena modified in synthetic processes. In this context, an important issue is the question of the dependencies between human, nature and machine.

Project was supported by

Topic: Art

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References:
http://vimeo.com/36210942
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Keywords:
audiovisual performance, field recording, somatic experience.

Marco Cardini

Live Performance:

TITLE: PAGe of light

Topic: Cyber Painting

Author:

Painting and music

Marco Cardini

Indipendent Artist

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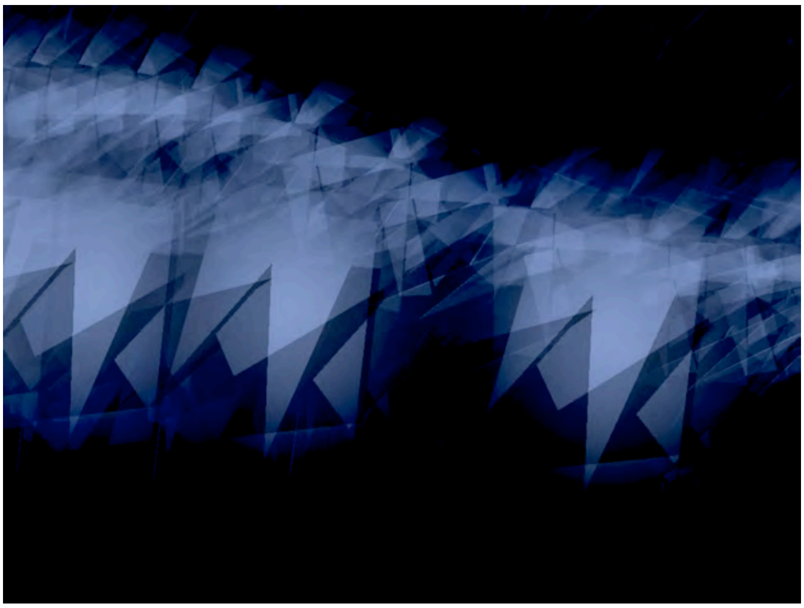
References:

Software PAGe MMM, (Painting by Aerial Gesture) Realized by ComputerART Lab ISTI – A.Faedo C.N.R. Pisa IT

Abstract:

During the 90's my research activity on Visual Art led me to focus attention on computers which were becoming more and more powerful, affordable and usable. I wanted to verify whether this new "electronic device" could satisfy my needs toward a new approach to digital art. Thanks to the collaboration with Computer Music Lab of CNUCE/C.N.R (today "*computerART Lab of ISTI/CNR, A.Faedo Institute, National Council of Research - Pisa*).

The PAGe MMM system consists of a program which allows the realization of visual/sound digital works of art executed in realtime under the control of the gesture of the performer. There are mainly two different operative phases: in the first phase PAGe MMM allows one to define and to prepare some presets organized in sequence as a storyboard. in the second moment PAGe MMM allows the true execution of the performance on stage by activating in real time all the operative possibilities previously stated in the presets.



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Keywords:
Cyber Art, Cyber Painting, Light Painting.

Robert Spahr

Live Performance:
Pattern Recognition (the memory of all that)

Topic: Computational Art, Appropriation,

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References:
[1] Jack Burnham "*Systems Esthetic*", Artforum, 1968
[2] Norbert Wiener, "*The Human Use of Human Beings Cybernetics and Society*", Da Capo Press, 1954
[3] Edited by Samuel Bercholz and Sherab Chodzin Kohn, "*The Budda and His Teachings*", Shambhala Publications, Inc, 1993
[2]
www.robertspahr.com

Abstract:
I am interested in how the ideas and images presented to us by the media affect our world view. As the ever present cable news cycle pushes a daily message of fear, filled with political polarization; domestic and foreign terrorism; recent kidnapped white girls; celebrity scandals; and the imminent threat of hurricane, earthquake or flood, I began to think about how these digital images and text operated, one day influencing our daily discourse, the next day vanishing without a trace. Digital leftovers reminded me of redundant computer programming. Code that was once useful, but later forgotten and obsolete.

Continuing my interest in computational art and live performance, this work will appropriate and remix source material from online main stream media web sites. Through the use of repetition and feedback, the live performance will contain a residue of it's own making. Memory within the work itself as well as within the mind of the viewer will become recursive, resulting in a self awareness as the audience experiences the computational process, artifacts will be created and the information will break down and a self reflexive mindfulness will develop.

Pattern Recognition (the memory of all that) 2012

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Keywords:
Cybernetics, indeterminism, mindfulness, feedback, CRUFT

Valery Vermeulen

(Performance) **Montage Cinema Revived by the EMO-Synth**

Topic: interactive multimedia & generative systems

Authors:
Valery Vermeulen Phd
Independent researcher
Phd in Pure Mathematics (University of Ghent)

References:
[1] Valery Vermeulen, "*The EMO-Synth, an emotion drive music generator*", eContact 14.2!, Canadian Electroacoustic Community, 2012 (http://cec.sonus.ca/econtact/14_2/vermeulen_emosynth.html)
[2] "EMO-Synth", Artefact Magazine, 2011
[3] Marc Leman, Valery Vermeulen et al.,"Correlation of gestural musical audio cues and perceived expressive qualities ", LNAI 2915, Springer-Verlag, 2004
[4] www.emo-synth.com

Abstract:
Montage Cinema Revived by the EMO-Synth is a new interactive multimedia project where the emotional impact of automatically generated sound and image is maximized using artificial intelligence techniques.

At the very heart of the technology used in the project lies the EMO-Synth, a generative soft and hardware system in which the emotional man-machine interaction plays a central role. Using the EMO-Synth involves two stages: a learning phase and a performance phase. In the learning phase the EMO-Synth will subsequently generate auditory artefacts and analyse the resulting emotional impact on the user. Using machine learning and statistical techniques the EMO-Synth learns in an adaptive way to generate sounds and music that bring the user in pre chosen emotional states. Once the learning phase has passed the EMO-Synth is ready to be used as a real time responsive multimedia tool. During performances knowledge build from the learning phase is used to generate realtime personalized soundtracks and live visuals. The visual material is hereby generated by the EMO-Synth and partially controlled by the same person placed in front of an audience. For every performance the EMO-Synth will seek to maximize the emotional impact of generated sound and image on the user. The live audiovisual concerts resulting from this experience intend to be unique and entirely based on the personal emotional feedback of the user.

The development of the EMO-Synth relies on a broad range of scientific and artistic disciplines including affective computing, genetic programming, advanced statistical modelling and algorithmic sound and image generation techniques.

Montage Cinema Revived by the EMO-Synth at art cinema offOFF (Ghent, Belgium)

This performance project was realised with the support of the Flemish Audiovisual Fund (www.vaf.be), Flanders Image (www.flandersimage.com) and Center for Digital Cultures and Technology (www.imal.org)

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Keywords:
affective computing, generative music and image generation, creative evolutionary systems, genetic programming, artificial intelligence, statistical modeling and biofeedback

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www.generativeart.com

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